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Conference Proceeding

THE 9th ANNUAL INTERNATIONAL SEMINAR ON TRENDS IN SCIENCE AND SCIENCE EDUCATION

Medan, Indonesia • November 8th, 2022

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9TH ANNUAL INTERNATIONAL SEMINAR ON TRENDS IN SCIENCE AND SCIENCE EDUCATION 2022
FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM
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Preface: Proceedings of the 9th Annual International Seminar on Trends in Science and Science Education (AISTSSE) 2022

This is the 9th meeting since it was first held in 2014 and the third virtual meeting due to the COVID-19 pandemic. We make the theme of this exciting forum is 'Development of Industrial-Based Research on Improving Research Innovation Strategy In Science and Science Education", which embraces six main topics, including: Mathematics, applied mathematics and statistic, Physics including theoretical physics and computation, geophysics, material science and technology, Biology including fundamental biology, and biotechnology, Chemistry including instrumentation, basic chemistry, and applied chemistry, then Science education and Computer science

The committee are really honored to have attention from approximately 130 speakers and participants from five different countries. They come from Netherland, Jordan, Japan, Malaysia, and of course Indonesia. The committee received more than 100 seminar abstracts from 15 University, from Diponegoro University, Kristen Indonesia University, Pendidikan Indonesia University, State University of Jakarta, State University of Malang, State University of Yogyakarta, State University of Semarang, State University of Surabaya, State University of Gorontalo, Sumatera Utara University, Muhammadiyah Sumatera Utara University, Muslim Nusantara Al-Washliyah University, Asahan University, Quality University and also of course from State University of Medan.

For this year conference, we invited six plenary speakers with solid expertise from different countries and regions. We are extremely grateful to: Prof. Dr. Syawal Gultom, M.Pd (The Senate Chairman of State University of Medan, Indonesia), Prof. Dr. Marleen Kamperman (University of Groningen, NETHERLAND), Prof. Tsunenori Mine (Kyushu University, JAPAN), Prof. Abedel Karrem Nasser M Alomari (Yarmouk University, JORDAN), and Romansyah Nasution (Casco Sea An Amphenol Group Batam, INDONESIA)

We also invite five invited speakers with different expertise field to initiate the presentation in parallel sessions. We are also extreme grateful to : Dr. Masrid Pikoli, S.Pd., M.Pd (State University of Gorontalo), Dr. Upik Nurbaiti (State University of Semarang), Dr. Eka Cahya Prima, (Pendidikan Indonesia University, Bandung), Dr. Dalia Sukmawati, and Dr. Meiliasari (State University of Jakarta)

Therefore, on behave of the committee, I would like to take this opportunity to extend my appreciation to the Rector of State University of Medan, The Dean of the Faculty of Mathematics and Natural Sciences, the invited plenary speakers, paper presenters, delegates and guests, and participants that have supported us to host this conference. In addition, my sincere thanks go to organizing team and student volunteers for un-tiring efforts to make this conference as a memorable one. We hope that you all enjoy this seminar and get the latest information about the progress of science and science education research and its application in the industrial field. Thank you very much for your attention, Wabilahi Taufiq Walhidayah, Assalamualaikum Warrahmatullahi Wabarakatuh.

Moondra Zubir, Ph.D
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Low-temperature sugarcane bagasse ash as additive materials for mortar applications

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Abstract. *Sugarcane Bagasse Ash (ScBA) has been reported to be beneficial as a cement additive due to the pozzolanic and the filler effect. The pozzolanic has been produced by burning bagasse and heating at 200 ℃ for 24 hours. In this study, measurements of the mortar's compressive strength, absorption, and porosity were carried out as a cube-shaped specimen with a size of 5 x 5 x 5 cm3. The variation of bagasse ash as an additive in the mortar was 0%, 3%, 6%, 9%, 12%, and 15%. It was found that the optimal percentage for mortar applications was in the sample with 3% ScBA supplementation. The addition of 3% bagasse ash increased 72.79 MPa the compressive strength of mortars, reduced the uptake of mortar water by 0.132%, and decreased porosity by 0.25% of mortars compare to a common mortar (CM). This result is supported by the microstructural pattern of the SEM image and confirmed by the FTIR and XRD data analysis. So that the low-temperature ScBA produced in this study qualifies as a cement additive as pozzolan material with ASTM standards.*

Keywords: additive; cement; mortar; pozzolanic; ScBA

Introduction

Mortar is a building material that glues masonry, concrete blocks, stucco, etc. The existence of mortar in construction is a necessity that is difficult to replace, therefore mortar continues to be developed to produce material compositions that suit every diverse need [1]. The ideal temperature for masonry mortar treatment and placement is in the range of 21-27 °C. In Indonesia, most of the mortar materials use portland cement and lime as a binder. You can imagine how terrible the impact on the environment would be if the use of portland cement was not controlled. The Portland

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cement production process is carried out at high temperatures [6], producing a lot of carbon dioxide (CO2). If the production of one ton of cement also emits one ton of CO2 which is equivalent to 7% of the world's total CO2 emissions [3–5], the side effects that must be paid for are expensive [2]. Therefore, various efforts have been made to reduce the environmental impact, one of which is to replace some portland cement with additional materials from industrial or agricultural waste [3,7,8]. In this study, ScBA was chosen as a substitute for portland cement because, in addition to its abundance amount, it also contains compounds that are very potent [2,7,9–11].

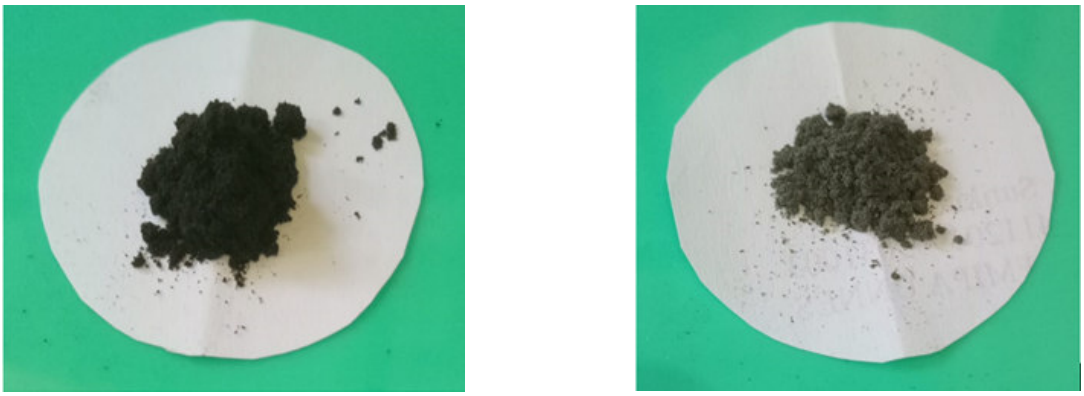
The function of ScBA as a partial substitution material for cement is because bagasse ash contains high silica (SiO2) around 60-80% [5]. Addition of ScBA more than 10% of previous studies aimed at increasing the initial setting, the longer the compressive strength is increasing and the more durable against aggressive environments. Furthermore, sugarcane is widely cultivated in Indonesia and the presence of bagasse has not been utilized optimally and its existence is still a waste. Indonesia has 64 sugar mills that operate with various production capacities and produce a large amount of residual burning of sugarcane bagasse in a boiler. The amount of ScBA is approximately 0.3% by weight of sugarcane, so if a sugar factory has a capacity of 5000 tons per day, the ScBA produced is 15 tons per day [1]. Meanwhile, previous research results confirm that the addition of SCBA in cement has provided a promising solution so that ScBA waste has the potential to be recycled and managed to make it more useful and not cause health and environmental problems. Therefore, this study aimed to optimize the preparation of ScBA with low-temperature treatment during the production process as an additive as a raw material for mortar.

Methodology

Starting materials

Here There are three main raw materials used as starting materials in this study which come from different resources, namely bagasse, cement, and sand. Bagasse is collected from sugar cane (the organic pulp after juice extraction) and burned until becomes dark ash [2,11], (Figure 1a). Dark ash with 100 mesh is heated in an oven at a temperature of 200 ℃ for 24 hours, this heating process occurs as the second burning process that produces gray ash (Figure 1b). The surface structure, shape, and size of ScBA particles are determined by an SEM on a Phenom XL Desktop TM SEM for a three-dimensional appearance. The chemical bond is determined by FTIR, mapped to a spectral resolution of 4 cm-1, and 256 scans encoded in the mid-infrared region (4000-400 cm-1) [12]. Meanwhile, the cement used is a commercial product of the Gresik brand (Type: PCC/Portland Composite Cement; SNI: 7064 – 2014), which has passed the ISO 14001 Management System trial process and has been proven to be an environmentally friendly product. Gresik cement's advantages include higher initial compressive strength, crack resistance, and smoother and faster drying with premium quality. The third material is sand from Muntilan, Central Java, Indonesia which has very specific characteristics.

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(a) (b)

Figure 1. ScBA powder a) combustion product and b) calcined 200 C.

Samples and characterization

The cubic specimens of mortar (5 x 5 x 5) cm3 were prepared on a laboratory scale by mixing sand, cement, ScBA, and water (Figure 2). The ratio of mortar admixture refers to previous research [1] conducted between cement: sand: water as much as 1: 2.75: 0.62 respectively. ScBA as a substitute for cement is replaced by variations of 0%, 3%, 6%, 9%, 12%, and 15% [11]. Mortar paste is molded until it is full. The finishing process is done by covering the mortar with a damp cloth for 24 hours [13]. Sample testing was carried out after the mortar was immersed in water for 23 days. Tests in this study include compressive strength, porosity, and absorbance. Pozzolan index was calculated based on [1], while the microstructure and dominant elements were mapped from SEM-Edx images.



Figure 2. To format a figure caption, use the microsoft word template style

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Results and discussion

Sand properties

Table 1 shows the results of the analysis of the properties of Muntilan sand, local natural sand with sizes between 8-200 mesh using an auto sieve machine for 15 minutes, this is in accordance with the permitted conditions - in the manufacture of mortar [9] which are summarized according to the Standards of the Testing and Equipment Center (BP2). Tests for specific gravity and percentage of sand absorption were carried out by testing 500 grams of sand according to SNI standards [7]. The density of Muntilan sand at a temperature of 25 ℃ of 2.57 kg/m^3 represents the ratio between the weight of the dry aggregate of the saturated surface and the weight of water whose contents are the same as the content of the aggregate in a saturated state, while the absorption percentage of 0.011% means the presence of pores in the aggregate. In addition to specific gravity, the density of 1.45 kg/m^3 was recorded as the weight of the aggregate per unit volume measured in solid or loose conditions and has air voids [8].

Table 1. Physical properties of sand.

Quantity	Specification	Value
Specific gravity (kg/m^3)	SNI 1970:2008	2.57
Absorption (%)	SNI 1969;2008	0.01
Content Weight (kg/cm^3)	SNI 06-2456-1991	1.45
Filter Analysis (mesh)	SNI ASTM C136-2012	8 - 200
Organic impurity	SNI03-2816-1992	Light brown
Clay lumps (%)	SNI 03-4142-1996	1.72
Sand Equivalent (%)	SNI 03-4428-1997	1.74

The color of organic impurity and clay lumps of Muntilan sands is indicated to exceed the permitted SNI standard limits. So, it needs to be washed with moving water before mixing with other ingredients.

Quality of ScBA

Figure 3 shows the FTIR pattern of ScBA powder before and after calcination. Both curves appear to have the same trend, but differ in the binding energy levels of each compound. Two different stretching groups are identified in the ScBA sample, one is a strong band between 468.34 cm^{-1} and 1115.49 cm^{-1} and the other one is broadband at 1442 cm^{-1} and 2354 cm^{-1}. The strong band indicates the presence of symmetric stretching vibration of silicon bonds. Sharp absorption peaks below 1400.03 cm^{-1}are recognized as relating to the stretching and bending of Si–O bonds. The SiO4 symmetric stretching vibration at 628,78 cm^{-1} and 789.19 cm^{-1} were observed clearly. The lowest bending mode of Si–O is noted at a band of 468.34 cm^{-1}. The wavelength band of 1115.49 cm^{-1} indicates that the quartz in the form in form of SiO_4 is in asymmetric vibrations, with the atomic arrangement as tetrahedral [14]. The broad band at 3616.80 cm^{-1} is due to symmetric and asymmetric vibration of (O–H) water bounded in ash particles due to its hygroscopic nature of it. Broad absorption bands are due to O–H stretching vibrations, with the broad asymmetric band at around 3616.80 cm^{-1} due to hydrogen-bonded molecular water molecules. All Si-O-Si, Si-C, Si-O, C-H, and O-H bonds are the constituent compounds of the hydrate-carbon-silicate bond (H-C-S) that affect the cement hydration pores.

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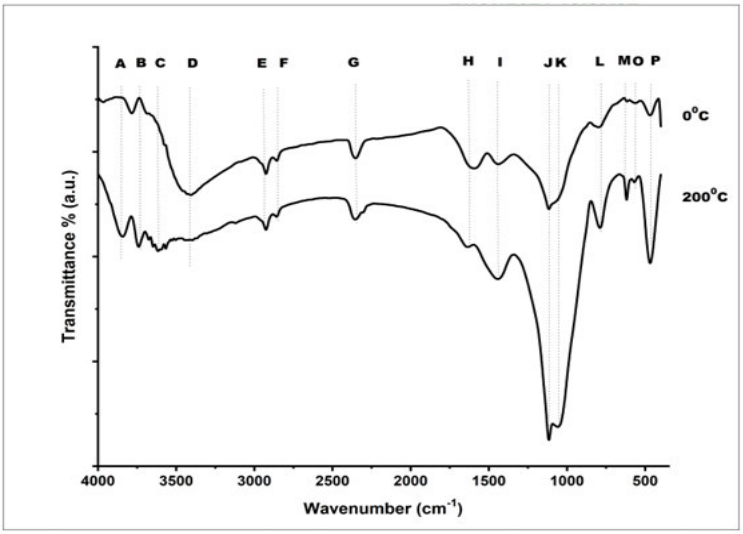


Figure 3. FTIR bagasse ash results before and after heating at 200 ℃

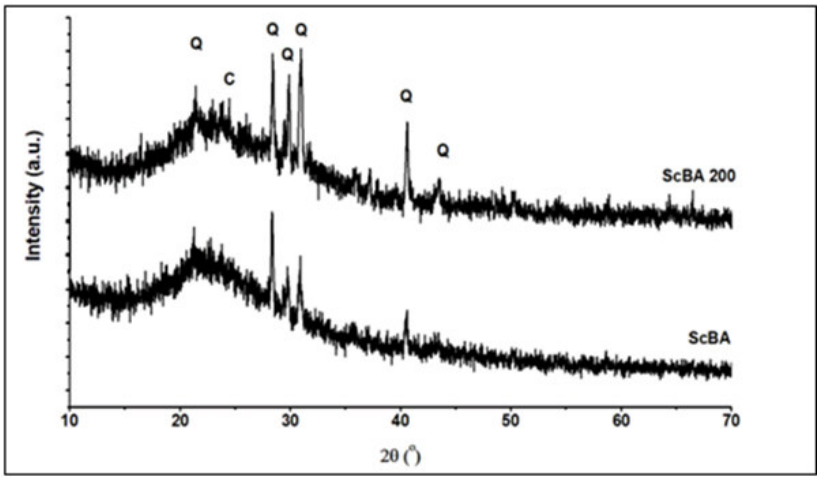


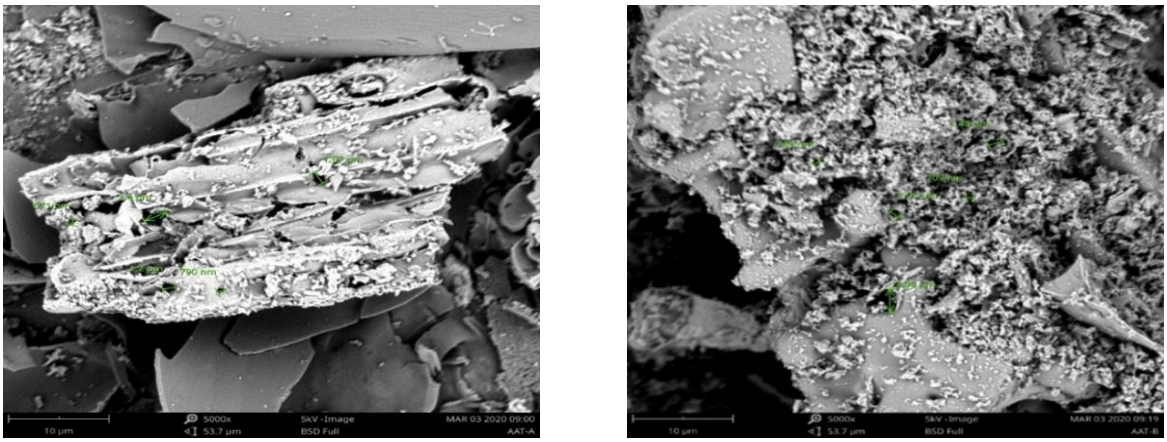
Figure 4. XRD pattern of bagasse ash before and after heating at 200 ℃

Figure 4 is the X-Ray Diffraction Pattern of ScBA and ScBA 200 powders, where the trend curves have similar characteristics. The peaks of the curve indicated the presence of SiO2 in the quartz (ICSD 1011159) and low-cristobalite (ICSD 9008110) phases, but with different intensities. This means that both powders have the same phase, as confirmed by FTIR results.

Morphological aspects of the ScBA particles observed by SEM are shown in figure 5. Heating bagasse at a temperature of 200 ℃ for 24 hours, causes a black color change to a gray color and a size reduction smaller than 200 mesh. This shows that there is a process of releasing carbon elements and splitting particles through the combustion process, and combustion occurs completely and imperfectly because there are still black particles. The difference in color before and after heating also refers to the silica content contained in the bagasse ash, after being heated the gray color of the bagasse ash is more than before being heated, and the gray color indicates the

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presence of silica elements [6,7] This is shown by the results of the EDX analyst in table 2. Figure 5a) and 5b) show the differences in surface structure, shape, and particle size of bagasse ash before and after heating. The surface of the bagasse ash after being heated has a smaller size with a higher level of homogeneity, which can be interpreted as the number of grains of more bagasse ash formed. This can be understood by the presence of coals that reduce the size and release some of the carbon dioxides. While the difference in color indicates the silica content contained in bagasse ash after being heated is more, see Table 2.



(a) (b)

Figure 5. SEM image bagasse ash a) before and b) after heating at 200 °C for 24 hours

Table 2. The ScBA composition of EDX results.

Symbol	Element	Before oven	After the oven 200^0 C
		Atomic Conc.	Atomic Conc.
C	Carbon	55.04	48.85
O	Oxygen	23.93	26.13
Si	Silicon	20.25	20.88
K	Kalium	0.78	3.82
Ca	Calcium	-	0.21
Mg	Mangan	-	0.10

Supplementary Cementitious Materials (SCM)

The character of the mortar material made in this study was compared to its strength with the ASTM standard mortar product. Laboratory scale testing was carried out at room temperature for compressive strength, porosity and absorption. The equation for the reaction that occurs in cement is C_3S (Alite) + $H_2O \rightarrow C_3S_2H_3$. While the reaction equation for silica and lime compounds is as follows:

$SiO_2 + Ca(OH)_2 \rightarrow CaO.2SiO_2.3H_2O$

$3CH + 2S \rightarrow C_3S_2H_3$.

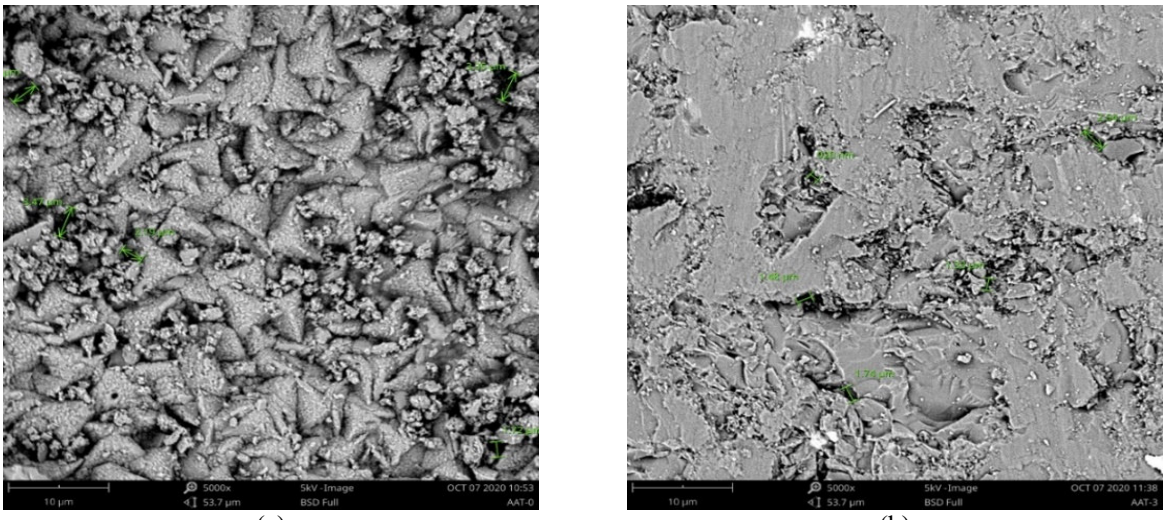
With the use of Muntilan sand after cleaning, there is quite a significant amount of water when mixing the mortar ingredients without reducing the workability of the mortar. The free water vapor

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dispersion rate and the reaction rate will increase when the cement compound reacts, so that the cement hydration process becomes perfect and the mortar becomes hard.

Mechanical properties of mortar

The pozzolanic activity of the mortars with ScBA replacement was determined from the relative strengths of the test mortars determined at 24 days. The pozzolanic indices of ScBA mortars (table 3) indicate a decrease in pozzolanic index with increasing ScBA content and are commensurate with other data presented. The minimum pozzolanic index (PI) or relative strength required to classify a material as a pozzolan is 75% [7]. The results here indicate that the M15 sample with a PI of 69.40 % falls below the required relative strength. This would appear to indicate that the ScBA contribution to strength development is more likely due to a pore filler effect rather than pozzolanic reactions and is commensurate with other observations [15]. The addition of pozzolanic materials can make the mortar more impermeable (reducing permeability) and aggressive, as a filler for the pores so that the mortar becomes denser, the presence of ScBA forms calcium silicate hydrates (C-S-H) compounds [16], this is evidenced by the morphological analysis of the mortar using SEM in Figure 6a and 6b where M3 has fewer cavities and closed surfaces than CM which has random and hollow surfaces. Based on the pozzolan index, the minimum compressive strength of mortar for this mixture is in the mortar (M12) with a strength of 452.18 MPa, and the optimum strength in the mortar (M3) with a strength of 602.84 MPa as much72.79 MPa from a normal/ common mortar [5,7].



(a) (b)

Figure 6. SEM image of a) a common mortar and b) mortar with adding 3% ScBA

Absorption in mortar is related to mortar porosity in the presence of air pores due to the cement molding process, cement water factor, and aggregate gradation selection [17]. The addition of ScBH as a filler and partial substitution of cement reduces the air pore in the mortar, this is due to the reduction of lime content in the cement which is residual but the excess addition of bagasse ash to the mortar only functions as a residue [4]. The lowest percentage of water absorption is in the mortar with bagasse ash as much as 3% with 1.40%, CM has water absorption of 1.53% and the highest water absorption is in the mortar M15 as much as 2.567%. The increase in water

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absorption and lower porosity of the mortar can increase the compressive strength. The addition of pozzolanic bagasse ash to the mortar reduces the empty space and affects the compressive strength of the mortar. The addition of optimum bagasse ash by 3% decreases normal mortar porosity by 0.25% while excess bagasse ash addition by 15% increases the porosity by 1,849%. Mortar porosity measurement results with variations in the addition of bagasse ash can be seen in Table 3.

Table 3. Center this text above the Table. Tables should have top and bottom rules, and a rule separating the column heads from the rest of the table only.

Sample Code	Porosity (%)	Absorption (%)	Strength (MPa)	Pozzolanic Index (%)
CM	3.09	1.53	530.05	100.00
M3	2.84	1.40	602.84	113.73
M6	3.10	1.57	506.76	95.61
M9	3.26	1.64	484.08	91.33
M12	3.55	1.78	452.18	85.31
M15	4.94	2.56	367.90	69.41

Conclusion

ScBA heated at 200 for 24 hours can be used for partial cement replacement. The addition of 3% ScBA produces a mortar that has optimum compressive strength and the use of ScBA up to 12% meets the standard compressive strength of mortar according to the ASTM standard. The addition of 3% bagasse ash can increase the compressive strength of mortar by 72.79 MPa from normal mortar, reduce water absorption by 0.13% from normal mortar and reduce porosity by 0.25% from the (CM). ScBA which is produced as a pozzolanic material produced at low temperatures as a partial replacement of cement meets ASTM standards with a maximum amount of ScBA of 12% with a mortal compressive strength of 452.18 Mpa.

Acknowledgments

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Antibacterial activity of ethanolic extract of sintrong leaves in inhibiting the growth of *Escherichia coli* causes diarrheal disease

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Abstract. *One of the main problems in the health sector in Indonesia is the high number of deaths from diarrheal diseases. Diarrhea is treated with antibiotics. The use of antibiotics in society creates a pattern of resistance and negative effects. This encourages various efforts in order to minimize the effects of antibiotics by using natural ingredients such as sintrong leaves. Sintrong leaves contain various secondary metabolites which are known to be able to inhibit the growth of various types of pathogenic bacteria. This study aimed to examine the ability of the ethanol extract of sintrog leaves to inhibit the growth of E.coli bacteria that causes diarrhea. The research method used is the agar diffusion method using disc paper. The sintrong leaves used are a collection of community plants. The extraction process uses the maceration method in order to obtain the ethanolic extract of sintrong leaves. This study used five concentration series, namely 5%, 10%, 15%, 20% and 30%. The results showed that from five series of treatment concentrations, the antibacterial ability of the ethanol extract of sintrong leaves started from the smallest 10.47 mm with a concentration of 5% and the highest at 18 mm with a concentration of 30%. The conclusion of this study is that the ethanolic extract of sintrong leaves has antibacterial ability against the growth of E. coli.*

Keywords: antibacterial, diarrhea, secondary metabolites, zone of inhibition, maceration

Introduction

Diarrhea is a disease that is still a health problem in many countries, especially developing countries such as Indonesia. The high number of deaths due to this disease is still a big concern of the government. Data and information from Indonesia's health profile show that the number of diarrhea cases in 2019 in Indonesia is still quite high for all ages, namely 270/1000 cases for the population and 843/1000 cases in toddlers.

Based on Indonesia's 2019 health profile, the frequency of outbreaks (extraordinary events) of diarrheal diseases fluctuated but the number of cases yesterday continued to increase. In 2015 there were 1,213 people in 13 provinces with a mortality rate of 2.47%, in 2016 there were 198 outbreaks in 3 provinces with a CFR (Case Fatality Rate) mortality rate of 3.03%. In 2018 there were 10 KLB cases spread across 8 provinces with 756 sufferers with a mortality rate of 4.76%.

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Diarrhea can occur due to infection or non-infection, but most of the cases of diarrhea that occur are caused by infection with pathogenic bacteria from viruses, bacteria or parasites. The most common cause of diarrhea after rotavirus is infection with Escherichia coli bacteria. Bettelheim said that E. coli is a commensal bacteria, intestinal pathogens and extraintestinal pathogens that cause urinary tract infections, septicemia and meningitis. E. coli bacteria are found in the digestive tract of humans and animals and are normal flora, but those that are pathogenic can cause diarrhea in humans. In some cases, E. coli is the bacteria with the highest number of infection cases [1].

Infections are often associated with the use of antibiotics, even though the use of antibiotics can cause various problems, even though their use is according to the doctor's recommendations. Some examples of side effects from the use of antibiotics are blood dyscrasias and severe skin reactions due to the use of cotrimoxazole, digestive tract disorders due to the use of ciprofloxacin, the use of aminoglycoside antibiotics which are toxic to the kidneys, and the most common are allergies and hypothrombin caused by the use of amoxicillin and cefadroxil [2].

In this case, due to the side effects caused by the use of antibiotics, it is necessary to use herbal medicines to reduce the side effects of using antibiotics to treat infectious diseases caused by bacteria or pathogenic microorganisms. Antibacterial compounds are substances that can interfere with growth, even kill pathogenic bacteria by interfering with the metabolism of these microbes. The mechanism of action of antibacterial compounds is by inhibiting cell wall synthesis, inhibiting the integrity of microbial cell membranes, inhibiting microbial cell protein synthesis and disrupting the metabolism of these microbial cells [3].

Indonesia, which is famous for its wealth of plants that have the potential as herbal medicines, which makes its people optimize the benefits of medicinal plants found based on hereditary experience with a simple process. used as a medicinal ingredient. Sintrong leaf extract is known to have the potential to suppress microbial growth [4].

The sintrong plant (*Crassocephalum crepidiodes* S. Moore) is one of the horticultural plant species that has the potential as a medicinal ingredient, but the lack of knowledge about the potential of this plant causes a lack of proper use of this plant so that it is more often considered a weed. *Crassocephalum crepidiodes* is an herb that grows wild in the tropics and sub-tropics, from another point of view this plant contains many properties that can be used as a wound healing drug, medicine for stomach aches/digestive disorders, anti-inflammatory, antidiabetic, antimalarial and as a cleanser wounds [5]. This sintrong plant is widely used as an ingredient for ointment, fresh vegetables and pecel. Sintrong leaves are part of the sintrong plant (*Crassocephalum crepidiodes* S. Moore) with various previous studies stating that the leaves of this plant contain secondary metabolites. Sintrong leaves (*Crassocephalum crepidiodes* S. Moore) contain essential oils, saponins, flavonoids and polyphenols. Sintrong leaf extract contains active compounds such as alkaloids and flavonoids that have the potential as antibacterial against Staphylococcus aureus and Bacillus cereus bacteria, and also as antifungals [6]. The ethanol extract of sintrong leaves at a concentration of 10% was able to inhibit the growth of S. aureus with an inhibition zone diameter of 3.16 mm [7].

Based on the above background from previous research, this sintrong plant contains secondary metabolite compounds that have antimicrobial potential, for that it is necessary to do further research to test the potential of sintrong leaf extract as an antibacterial against the growth of E. coli bacteria. Through this research, it is expected to see the potential of the sintrong plant which is widely known to the public as a weed plant or material for vegetables.

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Methodology

This research is planned to be conducted at the Laboratory of Microbiology FMIPA Medan State University, Jl. Williem Iskandar Pasar V Medan Estate. The time of the research was carried out starting from March 2022 – May 2022.

Population and sample

The population is the whole object of research. The population in this study is sintrong leaves, while the sample is part of the population that will be used in the study. The sample used in this study was sintrong leaves from plants that were still young and not yet flowering which were obtained from Hutasoit Village, Kec. Lintong Nihuta, Kab. Humbang Hasundutan, North Sumatra.

Tool

The tools that will be used in this research are a container, blender, analytical balance, tweezers, dropper pipette, erlenmeyer, stirring rod, measuring cup, hot plate, beaker glass, test tube, petri dish, ose needle, incubator, 60 mesh sieve, laminar air flow, autoclave, vortex, tube clamp, pH meter, bunsen, lighter, caliper, camera.

Ingredient

The materials that will be used in this research are sintrong leaves, Escherichia coli bacteria, sterile distilled water, Nutrient Agar (NA) media, spiritus, 96% ethanol, tissue, label paper, plastic wrap, disc paper, chloramphenicol.

Data collection technique

The data collection technique in this study was to observe the inhibition zone against the tested bacteria which was marked by the presence of a clear zone around the paper disc. The inhibition zone was measured using a caliper. The diameter of the inhibition zone is the diameter of the zone that is not overgrown by bacteria around the paper disc minus the diameter of the disc paper.

Research procedures

Tool sterilization

Before starting the research, all tools that will be used must be sterilized to prevent unwanted microbial contamination. The tools used are sterilized first, heat-resistant tools made of glass are sterilized using an oven at 170°C for 2 hours, while plastic and scale tools are sterilized in an autoclave at 121°C. for 15 minutes. Metal tools are sterilized by incandescent using a spirit lamp.

Material collection

The leaves of the sintrong plant that will be used in this study are the leaves of the sintrong plant that are still young or have not flowered with the characteristics of leaves not damaged or perforated due to caterpillar or insect bites, the leaves used are taken from the 3rd leaf obtained from the garden in Hutasoit 1 Village, district. Lintong Nihuta, Kab. Humbang Hasundutan, North Sumatra.

Material preparation

The leaves of the sintrong plant (*Crassocephalum crepidiodes* S. Moore) were sorted and washed using running water and aerated, then the sintrong leaves were cut into 2 parts and dried in an oven at 500C for 24 hours to dry. Furthermore, it is crushed using a blender and then sieved using a 60 mesh sieve to obtain a homogeneous powder.

Making extract of sintrong (Crassocephalum crepidiodes S. Moore)

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The extract of the leaves of sintrong (*Crassocephalum crepidiodes* S. Moore) was made by maceration. A total of 100 grams of sintrong leaf powder was put into 96% ethanol as much as 1000 mL (1:10) and allowed to stand for 3 x 24 hours at room temperature while stirring occasionally. Ethanol is an effective solvent used to attract polar and non-polar components, ethanol solvent is also easy to seep into the pores of plants so that it is stronger to bind the content of compounds present in plants which is shown through Setiawan's research. The extract was then filtered to separate the pulp and the filtrate. Furthermore, the filtrate was evaporated at a temperature of 40^{o}C until no more solvent dripped so that a thick extract was obtained. Based on Maimunah's research Sintrong leaf extract solution tested on Staphylococcus aureus at a concentration of 10% is an effective concentration to inhibit the growth of bacteria with a diameter of 6.5 mm. Therefore, in this study, a concentration of antibacterial activity tests for Escherichia coli bacteria will be made with variations in concentrations of 5%, 10%, 15%, 20%, and 30%.

Media manufacturing and sterilization

The media used is nutrient agar media. A total of 10 grams of NA was dissolved into 500 ml of distilled water, then heated on a hot plate. The solution was heated to a clear yellow color and then poured into a sterilized Erlenmeyer. Then the media was sterilized in an autoclave at 1210C at 1 atm pressure for 15 minutes. The sterile media was poured into a petri dish as needed. After the media solidified, the media was incubated at 37°C for 24 hours.

Rejuvenation and manufacture of Escherichia coli bacteria suspension

Bacteria to be rejuvenated were obtained from the regional Health Laboratory, North Sumatra Provincial Health Office, Jl. Williem Iskandar Pasar V Barat No. 4 Medan, North Sumatra. The process of rejuvenation of *Escherichia coli* test bacteria on sterile NA media that had been prepared previously. The test bacteria were rejuvenated by scratching using a sterile ose needle on the LAF. After that, the test bacterial cultures were inoculated at 370C for 24 hours (Izudin, 2020). The rejuvenated bacteria were then colonized using a sterile ose needle and inserted into the BHI-B medium in a test tube and then incubated for 24 hours. After that, the Escherichia coli suspension was made according to the standard McFarland 1 turbidity equivalent to 0.3 x 109 bacteria/ml.

Antibacterial activity test and minimum inhibitory level

Antibacterial activity test was carried out by agar diffusion method (Kirby-Bauer test) using paper discs with 3 repetitions. The media used in this test is NA media. Disc paper serves as a place to accommodate antibacterial substances. The sterilized disc paper was soaked in sintrong leaf extract for 30 minutes. Then the disc paper was taken using sterile tweezers, then the disc paper was placed on a petri dish containing NA media that had been inoculated with the test bacteria then all the plates were wrapped in plastic wrap and incubated at a certain time and temperature, according to the optimum conditions of the test bacteria, namely at 37°C for 18-24 hours. After incubation, the diameter of the clear zone formed was measured. Samples that have potential as antibacterial are indicated by the formation of a clear zone [8].

Barrier zone measurement

The diameter of the inhibition zone was measured by measuring the clear zone formed using a caliper. The diameter of the inhibition zone is the diameter that cannot be overgrown by fungi around the disc paper minus the diameter of the disc paper. The activity of the inhibitory zone of an antimicrobial is grouped into four, namely:

Data analysis

The data analysis used in this research is descriptive analysis. The data obtained from this research are in the form of qualitative and quantitative data. The qualitative data in this study

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included antibacterial activity tests, while the quantitative data in this study included the results of measuring the diameter of the inhibition zone on the antibacterial activity test and the minimum inhibitory concentration test (MIC) of sintrong leaf extract (*Crassocephalum crepidiodes* S. Moore).

Results and discussion

The results showed that the ethanol extract of sintrong leaves was able to inhibit the growth of Escherichia coli bacteria. The series of ethanol extract concentrations tested started from 5%, 10%, 15%, 20% and 30%. The ability to inhibit the activity of the ethanol extract of sintrong leaves against Escherichia coli bacteria at a concentration of 5% was able to inhibit the formation of an inhibition zone of 10.47 mm by the agar diffusion method using disc paper (Table 1).

Table 1. Inhibitor zone of ethanolic extract of sintrong leaves

Bacterial	Concentration				
	5%	10%	15%	20%	30%
Escherichia coli	10,47	11,67	13,73	15,37	18,00

Source: Authors' own research

The antibacterial activity of the ethanol extract of sintrong leaves in inhibiting the growth of E.coli bacteria showed that the higher the concentration used, the better the inhibition of E.coli growth. At a concentration of 30%, an inhibition zone of 18.00 mm was obtained which is the best zone of inhibition (Figure 1).

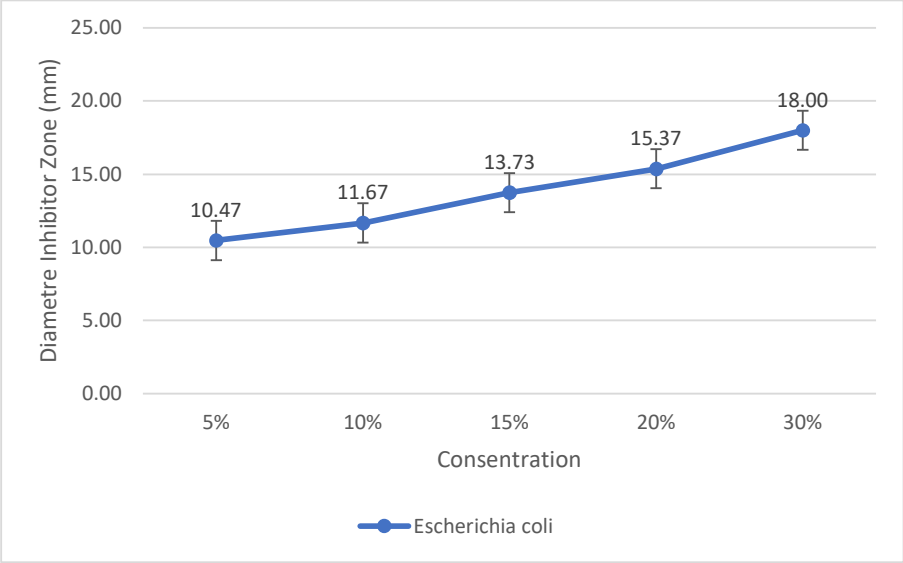


Figure 1. Diameter inhibitor zone in variation concentration

Based on the results of the research that has been carried out, it is found that the ethanol extract of sintrong leaves is able to inhibit the growth of E. coli bacteria. It can be seen that there is a clear zone which indicates the absence of bacterial growth. This happens because plants contain secondary metabolites. Sintrong leaves (*Crassocephalum crepidiodes* S. Moore) contain essential oils, saponins, flavonoids and polyphenols. Sintrong leaf extract contains active compounds such as alkaloids and flavonoids that have the potential as antibacterial against *Staphylococcus aureus* and *Bacillus cereus* bacteria, and also as

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antifungals [9]. For plants, secondary metabolites function as substances to defend themselves from possible unfavorable environmental conditions or pests and diseases [10]. Secondary metabolites are metabolic compounds that are not essential for the growth of organisms and are found in unique forms or differ from one species to another.

The content of flavonoids, tannins and saponins in sintrong leaves can inhibit the growth of pathogenic microbes. Flavonoids are known to be able to kill microbial cells and resist toxins released by pathogenic microbes. Tannin compounds are able to inhibit bacterial growth because they form complex compounds with proteins through hydrogen bonds, if hydrogen bonds are formed between tannins and proteins, the protein will be denatured so that bacterial metabolism is disturbed [11]. Meanwhile, the mechanism of action of flavonoids is by damaging the bacterial cell membrane in the phospholipid section, thereby reducing the permeability which causes the bacteria to be damaged. Flavonoids refer to secondary metabolites from plants that have a phenylbenzopyrone structure, commonly known for their antioxidant activity. Flavonoids are the largest group of phenolic compounds found in nature. These compounds are red, purple and blue dyes and are yellow dyes found in plants. Flavonoids have a basic carbon framework consisting of 15 carbon atoms, where two benzene rings (C6) are bonded to a propane (C3) chain to form a C6–C3–C6 arrangement. This arrangement can produce three types of flavonoid compound structures. Examples of flavonoid compounds, including isoflavonoids.

Conclusion

Based on the results of research that has been carried out to see the antibacterial activity of the ethanolic extract of sintrong leaves in inhibiting the growth of E.coli bacteria as one of the causes of diarrheal disease, it was found that the ethanolic extract of sintrong leaves has the ability as an antibacterial inhibiting the growth of E.coli. Based on these results, it was also found that the higher the concentration of the ethanol extract of sintrong leaves, the higher the ability of the antibacterial activity of the ethanolic extract of the leaves of sintrong to inhibit the growth of E.coli bacteria.

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Analysis of the anatomical characteristics of the modified spermatohyte plant organs

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Abstract. *Root, stems and leaves are the main organ in spermatophyte plants. In the growth and developmentof a plant, the main organs can undergo changes in structure and function. In other word the root, stems and leaves of spermatophyte can be modified. These modificatiob of root, stems and leaves occur due to the adaptation of plant to certain conditions or the presence of additional function the organ. The modification of the main organs means there is a change in the morphological structure and also a tendency to change the anatomical structure of the organ. Analysis of the anatomical characteristics of the modified spermathophyte plant organs through direct observation of the anatomical structure of the organ specimens. Description of the anatomical characteristics of plant organs that modification canbe used as alternative reference in studying the anatomical structure of spermathophyte plants. The anatomical structure of thr organ which a modification of root, stem and leaves has the same basic pattern as the anatomical structure of roots, stem and leaves in general.*

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However, there are speciality of anatomical characters according to changes in function and adaptation to certain condition.Example: the presence of velamen tissue on the aerial roots of orchid; a large of stele area composed by parenchyma in carrot root tuber; stele area composed by parenchyma which stores food reseves on potato stem tuber. So, the anatomical structure of the modified organs still have the same anatomical structure pattern as the main organs, but these organs have distinctive anatomical characteristics according to changes in their function or adaptation to a condition.

Keyword: the anatomical characteristic, modification, plant organ, Spermathophyta

Introduction

Spermatophyta is a group of seed plants. This plant group has three main organs namely roots, stems, and leaves. Besides the three main organs, spermatophyta plants have organs that have undergone modifications in structure and function. This modification or change in structure occurs in its morphological and anatomical characters. Changes in structure as a pattern of plant adaptation to a condition. The anatomical structure of the modified organs has a structural pattern similar to the anatomical structure of the main organs with variations according to their function. Organs that are modifications of roots, for example aerial roots/hanging roots, convoluted roots, suction roots, stilt roots, attached roots, breath/pneumathopores roots, and root tubers. Examples of plant organs that are modifications of stems include stem tubers, stolons, rhizomes, and branch tendrils. Examples of modified plant organs from leaves such as leaf tendrils, spines on cactus plants, scales on tubers, scales on rhizomes, and others.

Aerial roots have special adaptive anatomical characteristics, that is having a double epidermal tissue structure called velamen which functions is for water absorption; On the inside of the velamen is the exodermis which has several thin-walled passing cells [4]. Haustorium (sucking roots) has a tracheal elemental structure with a distinctive development [4]. The stem tuber as a storage organ for food reserves has a distinctive structure. The stem tuber *Ipomoea batatas* have a lot of parenchyma tissue; visible secondary growth around vascular tissue [4].

There are still many anatomical characters of plant organs that have undergone modifications from the main organs that have not been explored either from roots, stems or even those that are modified from leaves. Rhizomes, like those of the *Zingeberaceae* family, are actually stems and leaves that are found in the soil, which are a place for storing food reserves [8]. Judging from this function, of course, the rhizome has an anatomical character that is different from the anatomical structure of monocot stems in general. In terms of their origin, the bulbs are the incarnation of the stems and their leaves [8]. Observing the morphological structure of the discs or scales that are owned by the tuber, it can be assumed that the tuber has an anatomical structure that is different from the anatomical structure of its original organ. Tendril (cirrhus) is a winding tool which is usually in the form of a spiral which can come from a branch or from a leaf. Based on these functions, it can be predicted that the anatomical structure of tendrils is different with the anatomical structure of the organ of origin.

From the description above, it is very important to explore the variations in the anatomical structure of plant organs which are modifications of roots, stems and leaves. The results of this exploration can add information about the diversity of anatomical characters of plant organs.

Methodology

The research was conducted at the Structure and Development Laboratory – Biology Laboratory, Faculty of Mathematics and Natural Sciences, Universitas Negeri Medan.

The objects/materials of this research were 20 modified plant organs, namely the radix aureus of *Orchidaceae*, haustorium of *Loranthus sp*., the radix stilt of *Pandanus amaryllifolius*, the tuber rhizogenum of *Daucus carota* L., the radix aureus of *Ficus benjamina* L., the tuber caulogenum of *Solanum tuberosum* L., the tuber caulogenum of *Ipomoea batatas* L., bulbus of *Allium ascalonicum* L., rhizoma of *Curcuma domestica* Val., rhizome of *Kaempferia galangal* L., rhizoma of *Alpinia*

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galanga L., rhizoma of *Zingeber officinale* Rosc., stolon of *Centela asiatica* L., stolon of *Imperata cylindrica* L., cirrhus of *Sechium edule* , cirrhus of *Cucurbita mooschata* Duch., cirrhus of *Momordica charantia*, cirrhus of *Passiflora edulis* Sims., cirrhus of *Cucumis sativus* L. and cirrhus of *Gloriosa superba* L.

The type of this research is descriptive-explorative. The research was conducted in two stages. The first stage was the manufacture of permanent anatomical preparations from 20 modified plant organs using the paraffin method. The second stage is the exploration of the anatomical characters of the modified plant organs through observation and description of the anatomical structures of the 20 anatomical preparations.

Results And Discussion

Anatomical preparations of modified plant organs

From the results of the study, 20 anatomical preparations were obtained from modified organs, shown in the following figure.

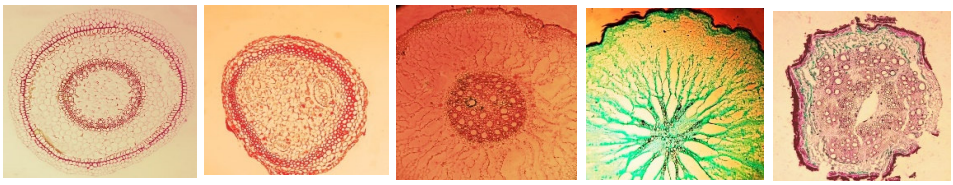


Figure 1. radix aureus *Orchidaceae,* **Figure 2.** haustorium *Loranthus* sp., **Figure 3.** radix stilt *Pandanus Amaryllifolius,* **Figure 4.** tuber rhizogenum *Daucus carota* L., **Figure 5**. radix aureus *Ficus benjamina* L.

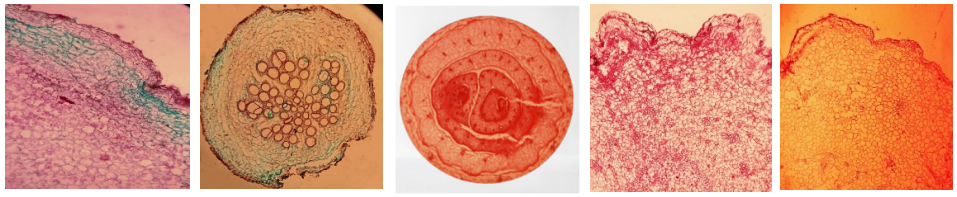


Figure 6. tuber caulogenum *Solanum tuberosum* L., **Figure 7.** tuber caulogenum *Ipomoea batatas* L., **Figure 8.** bulbus *Allium ascalonicum* L., **Figure 9**. rhizoma *Curcuma domestica* Val., **Figure 10.** rhizoma *Kaempferia galangal* L.

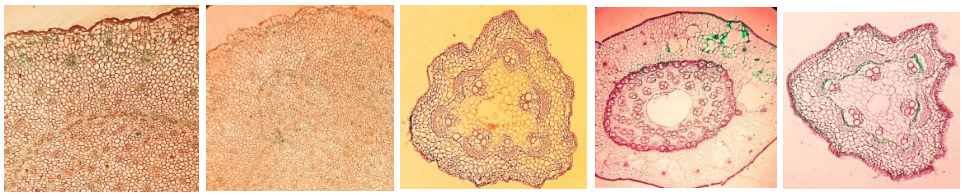


Figure 11. rhizoma *Alpinia galanga* L., **Figure 12.** rhizoma *Zingeber officinale* Rosc., **Figure 13.** stolon *Centela asiatica* L., **Figure 14.** stolon *Imperata cylindrica* L., **Figure 15.** cirrhus *Sechium edule*



Figure 16. cirrhus *Cucurbita mooschata* Duch., **Figure 17.** cirrhus *Momordica charantia.,* **Figure 18.** cirrhus *Passiflora edulis* Sims., **Figure 19.** cirrhus *Cucumis sativus* L.**, Figure 20.** cirrhus *Gloriosa superba* L.

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Description of the anatomical structure of the modified organs

Radix aureus anatomy of Orchidaceae

The outer layer of the orchid root consists of a layer of velamen radicum which is a double epidermal tissue. Velamen consists of several layers of cells, the walls are reinforced with lignin. In addition, Hauber explain that the velamen radicum encloses the root completely and consists mostly of several layers of dead cells (in some orchids, there are only one or two layers of velamen radicum cells). Velamen radicum functions as a protective tissue, preventing water from escaping from the cortical cells, storing water/air [5]. Next to the velamen tissue there is a cortical area dominated by parenchyma tissue. Cortex parenchyma tissue is generally relatively large in size with thin cell walls. The outermost part of the cortex tissue differentiates into the exodermis which consists of long cells and short cells, thickened cell walls with lignin and suberin substances. The function of the exodermis is for mechanical protection and keeping the cortex tissue moist. The innermost tissue of the cortex differentiates into the endodermis. Transport tissue is on the inside of the endodermis layer. Xylem and phloem are arranged radially with the polyarch type.

Haustorium anatomy of Loranthus

The epidermis layer consists of a single layer of epidermal cells. Next to the epidermis are areas of the cortex. The cortex is composed of parenchyma tissue, which is relatively denser than the arrangement of parenchyma tissue in the root stele. In the cortex area towards the inside (lateral part), there are several layers of sclerenchyma reinforcement tissue arranged in a circle. The innermost cortex tissue differentiates into endodermal tissue. The vascular is inside the endodermis with the tetrarch type. The pith area is mostly composed of parenchyma tissue.

Radix stilt anatomy of Pandanus amaryllifolius,

The epidermis layer is composed of a single layer of epidermal cells that cell walls are thickened. Inside the epidermis, there is exodermis tissue, which is composed of 1-2 layers of cells that are larger in size than the epidermal cells. Beneath the exodermis is a cortical area dominated by parenchyma cells with very large intercellular spaces called aerenchyma. In the outer cortex area towards the periphery is composed of ring-type collenchyma tissue. In addition, there are many vascular bundles in the stele section of the stilt root. Fiber bundles and secretions in the form of crystals are scattered inside the endodermis [2].

Tuber rhizogenum anatomy of Daucus carota L.

The outermost layer consists of epidermal cells. On the inside of the epidermis there is a hypodermis tissue in the form of tightly packed collenchyma tissue with a relatively thicker cell wall. Inside the hypodermis there is a cortex, containing a relatively loose arrangement of parenchyma cells. The more towards the periphery, the arrangement of parenchyma cells is getting denser. Stele is composed of xylem and phloem tissues which are arranged radially as well as the type of transport tissue in roots. Parenchyma tissue in the stele area is very loose.

Radix aureus anatomy of Ficus benjamina L.

On the outside there is the exodermis which is a cork tissue composed of cells that are slightly rounded in shape and function as a protective tissue. Inside the exodermis is a cortical area, which is mostly composed of parenchyma tissue with large intercellular spaces. In the outermost stele area there is dilation tissue consisting of parenchyma tissue and most of the collenchyma tissue.

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Tuber caulogenum of Solanum tuberosum L.
The epidermis is composed of a single layer of epidermal cells. On the inside of the epidermis are narrow cortical areas. The cortex contains compressed parenchyma cells in a tightly packed arrangement of cells, and very small intercellular spaces. The stele area is dominated by parenchyma tissue containing amylum grains. Parenchyma in the stele area towards the periphery of the cell is denser than the arrangement of parenchyma cells towards the center. The transport tissue is in the outermost stele area. The stele area occupies the largest part of stem tuber cross section of *Solanum tuberosum* L.

Tuber caulogenum anatomy of Ipomoea batatas L.
The epidermis is composed of a single layer of epidermal cells. Beneath the epidermis is a layer of lamellar type coenchyma tissue. The cortical area is narrow, dominated by parenchyma cells with a rather tight arrangement in the cortex to the outside, and parenchyma with a looser arrangement of cells with lots of inter-cell spaces to the steles. The stele area is densely packed with transport tissue. The transport tissue is arranged like the transport tissue in dicot stems that experience secondary growth. In the stele area, there is also parenchyma tissue between the transport tissues.

Bulbus anatomy of Allium ascalonicum L.
The anatomical structure of the scales resembles the anatomy of a leaf which is composed of the upper epidermis, lower epidermis, and the mesophyll area tissue that is found between the two epidermises. In the mesophyll there is parenchyma and transport tissue that is found between the parenchyma. Parenchyma is composed of relatively large cells with small spaces between cells. The anatomical structure is like scales because the scales are modifications of the leaves. The most central area is the disc, its anatomical structure is similar to the monocot stem.

Rhizoma anatomy of Curcuma domestica Val.
The epidermis is the outermost layer composed of a single layer of cell. Inside the epidermis there is a hypodermis which is composed of 1-2 layers of cells. The area on the inside of the hypodermis is dominated by parenchyma tissue. The cortex and stele areas are difficult to distinguish because the vascular tissue is scattered between the parenchymal tissues. The location of the vascular tissue is similar to the anatomy of the monocot stem, namely it has a collateral type. This is in line with the Trimanto research that the vascular tissue is spread throughout the rhizome, the type of vascular tissue in turmeric rhizome is closed collateral. In the parenchyma tissue, there are many amylum grains. Amylum grains in rhizomes are oval and round [9]. Most of the rhizome of *Curcuma domestica* L is makes up by parenchyma tissue. This anatomical structure is in accordance with the function of the turmeric rhizome as a place to store nutrients.

Rhizoma anatomy of Kaempferia galangal L.
The epidermis is the outer layer of the rhizome of *Kaempferia galanga* L. which is composed of a single layer of the cell. Inside the epidermis, there is a hypodermis which is composed of 1-2 layers of cells. The cortex area is composed of parenchyma tissue which is arranged relatively tightly. In parenchyma cells, there are many glycosides, alkaloids, tannins, and flavonoids. Collateral type transport tissue, scattered among the parenchyma tissue. The parenchyma tissue also contains idioblast cells which contain atsiri oils.

Rhizoma anatomy of Alpinia galanga L.
The outermost part is composed by a single layer of epidermal tissue, on the inside the epidermis is dominated by parenchyma tissue down to the pith area. The transport tissue is spread among the parenchyma tissues, starting from the bottom of the epidermis to the pith area. There are different features in the anatomical structure of this rhizome compared to the anatomy of monocot plant stems,

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namely in the median area the vascular tissue is arranged in a circle around the stem as the arrangement of vascular tissue in the stem of dicot plants. The arrangement of the transport tissue in the median area seems to limit the cortex area and the stele area, even though the anatomical structure of monocot plant stems is generally very difficult to distinguish between the cortex and stele areas.

Rhizoma anatomy of Zingeber officinale Rosc.

On the inside of the epidermal layer up to the pith/medulla area of the rhizome is filled with parenchyma tissue that cell size is relatively small, the spaces between cells are small. The transport tissue is spread among the parenchyma tissue starting from the bottom layer of the epidermis to the pith area, this arrangement is like the arrangement of the transport tissue in monocot stems. There is a slight variation in the distribution pattern of the transport tissue, namely in the median area there is a transport tissue arranged in a circular rhizome, this arrangement is like the arrangement of the transport network of dicot plant stems. Based on the research of Liu, that in pericycle present the vascular bundles in collateral in a ring, and starch grains are present in the cortex and pith in young rhizome but it will decrease while there is an increase of oil cells and secretory cavities proliferation [7].

Stolon anatomy of Centela asiatica L.

Inside the epidermal layer, to be precise at the ribs of the stolon, there is angular type collenchyma tissue as a supporting tissue. The cortex area is mostly composed by parenchyma tissue. In the cortex area there are several idioblast cells as a secretory tissue. The stele region consists of transport tissue and parenchyma. The collateral type of vascular tissues are arranged around the organs, and on the outside of each vascular tissue is sclerenchyma tissue. The pith is composed of parenchyma tissue.

Stolon anatomy of Imperata cylindrica L.s

The outermost layer is composed of a single layer of epidermal cells. Inside the epidermis there are 1-2 layers of collenchyma tissue with an angular type. The cortex and stele areas are clearly visible, unlike the stems of monocotyledon plants in general, where the cortex is not clearly visible because of the scattered arrangement of the transport tissues. The stolon cortex area is dominated by parenchyma tissue with lots of space between cells, there are idioblast cells scattered circularly on the lateral side. Closed collateral-type transport tissue. The arrangement of the transport tissue is spread out like the arrangement of the transport tissue on the stem of monocot plants, but the transport tissue on the outermost part of the stele is arranged regularly in a circular organ so that it appears that the transport network limits the stele area to the cortex.

Cirrhus anatomy of Sechium edule

The outer layer of the branch tendrils of the *Sechium edule* is composed of a single layer of epidermal cells. The cortex is equipped with collenchyma tissue arranged in a circle under the epidermis. Collateral-type transport tissue arranged in a circle around the organ. On the outside of each vascular tissue there is sclerenchyma tissue as a supporting tissue. The pith is composed of parenchyma tissue with relatively large cell sizes.

Cirrhus anatomy of Cucurbita mooschata Duch.

The outermost part of the tendrils is composed of epidermal tissue. In this epidermal layer there are papillae (derivatives of the epidermis). Inside the epidermis there are several layers of collenchyma tissue with a lamellar type. The vascular tissue is bicollateral type, arranged in a circular arrangement of organs like the arrangement of the vascular tissue in the stem, this observation conforms with the finding of Ekeke, that in the tendrils and fruit stalk they find the presence of bicollateral vascular bundles. The vascular tissue in tendrils only consists of 1 circle, while the transport network in the stem consists of 2 (two) circles, namely the transport tissue in the peripheral circle and in the median circle, this observation conforms with the finding of Ekeke, that in the tendrils the vascular bundles formed a

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single concentric ring. Parenchyma tissue dominates from the inside of the hypodermis to the stele [3].

Cirrhus anatomy of Momordica charantia

The anatomical structure of the branch tendrils of *Momordica charantia* resembles the pattern of the anatomical structure of *Cucurbita moschata* Duch. The outermost layer of the tendrils is composed of a single layer of epidermal cells. Under the epidermal layer there are 2-3 layers of lamellar type collenchyma tissue, which is the strengthening tissue of the tendrils. The transport tissue is arranged in a circular cirrhus cross-section with collateral type. On the outside of the transport tissue there is a lacunar type collenchyma strengthening tissue, where the collenchyma cells experience thickening of the cell wall on the side facing the intercellular space. This collenchyma tissue very clearly demarcates the cortex and stele in the vine. The existence of a layered collenchyma reinforcing tissue on the cross section of the *Momordica charantia* cirrhus makes these sturdy enough to tie the plants to the support poles, so that the plants can propagate upright on the support poles.

Cirrhus anatomy of Passiflora edulis Sims.

The outermost layer is composed of a single layer of epidermal cells. The cortex is not clearly visible. Transport tissue with a collateral type arranged in a circular organ. The stele area is broad and composed of angular type collenchyma tissue to the outside while towards the inside the stele is composed of parenchyma tissue, which is relatively densely structured. Spaces between cells are formed in the parenchyma tissue because of the hexagonal shape of the cells.

Cirrhus anatomy Cucumis sativus L.

The outermost layer is composed of epidermal cells. Next to it is cortex, which is mostly composed of collenchyma tissue. Inside the cortex there is a stele consisting of collateral-type transport tissue arranged in a circle of tendril organs and there is parenchyma tissue with relatively large cell sizes with small inter-cell spaces. The epidermis, cortex, and stele are not circular because the cross-section of the tendrils is not circular.

Cirrhus anatomy of Gloriosa superba L.

The epidermis is composed by a layer of cells that are tight, the cell size is small and arranged upright like a fence. Under the epidermal layer there is collenchyma tissue. Between the upper epidermis and lower epidermis after collenchyma is mostly composed by parenchyma tissue. The composition of the parenchyma cells is relatively dense. Transport tissue arranged horizontally in the center of the organ. The arrangement of dense mesophyll tissue in leaf tendrils is in accordance with the function of leaf tendrils or convoluted leaves, namely as a twisting / binding device on a support pole.

Conclusion

Main organs such as roots, stems, and leaves of plants can experience changes in anatomical characteristics. Changes in the anatomical structure of the main organs correspond to changes in organ function as a form of adaptation to a condition. Changes in the morphological structure of roots are in line with changes in its anatomical structure into other organs such as aerial roots (hanging roots), stilt roots, entwined roots, adhering roots, and root tubers. Likewise, changes in the morphological structure of the stem are in line with changes in its anatomical structure into several other organs including stem tubers, bulbs, stolons, rhizomes, and tendrils. Leaves can change into tendrils, spines, and fine hairs. The stem and leaf organs together can undergo modification into other forms such as bulbs which are modifications of the stems and leaves. The discs on the bulbs of *Allium ascalonicum* L. are actually stems and the scales on the bulbs are actually leaves, this can be seen from their morphological and anatomical characters. The rhizome of *Alpinia galanga* L. is actually a stem and the scales on the rhizome are leaves.

Even though there is a change in the anatomical structure of the main plant organs into other forms,

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the anatomical structural pattern of the modified organs remains similar to the anatomy of the main organ with variations in the anatomical pattern according to the function of the organ.

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Antibacterial activity of durian peel ethanol extract in inhibiting the growth of pathogenic bacteria

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Abstract. *The purpose of this study was to determine the potential antibacterial activity of durian peel ethanol extract in inhibiting the growth of pathogenic bacteria. The durian skin used in this study is a fresh durian skin obtained from the area around the city of Medan which is sourced from durian fruit traders in the city of Medan. Durian skin samples were taken from durian traders and then wet sorting was carried out, the purpose of this wet sorting was to choose durian skins that were good and not rotten. The extract of durian skin (Durio zibethinus Murr) was made by maceration method using 96% ethanol as solvent. Durian peel extract solution was made with various concentrations of 60%, 50%, 40%, to test the antibacterial activity of the extract. Antibacterial activity test was carried out by agar diffusion method (Kirby-Bauer test) using disc paper. The diameter of the inhibition zone was measured by measuring the clear zone formed using a caliper. Based on the measurement results of the antimicrobial activity test of the durian peel waste ethanol extract which was tested on 4 types of test bacteria, the results were obtained by looking at the diameter of the inhibition zone formed. Based on the research data, it was found that the best concentration to inhibit growth for all types of pathogenic bacteria was at a concentration of 60%. Inhibition has been seen from the smallest concentration at a concentration of 40%. The conclusion of this study is that the greater the concentration of the extract, the greater the inhibitory ability.*

Keywords: extraction, ethanol, antibacterial, inhibitor zone, pathogen

Introduction

Antibacterial is a compound produced by microorganisms and in small concentrations that can inhibit and even kill the life processes of microorganisms [1]. Antibacterials are compounds used

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to control the growth of harmful bacteria. Controlling the growth of pathogenic microorganisms aims to prevent the spread of disease and infection. In the pharmaceutical field, antibacterial substances are known as antibiotics, which are chemical substances that can inhibit the growth of other microbes. The purpose of measuring antibacterial activity is to identify and determine the potential of a substance that is thought to have antibacterial activity against a bacterium [2]. This potential continues to be explored due to the increasing resistance of pathogenic microbes to antibiotics.

The use of antibiotics that are not in accordance with doctor's recommendations, whether lacking or excessive, is one of the biggest contributors to the number of antimicrobial resistance (AMR) in the world of health. Based on data from the World Health Organization (WHO), the use of antibiotics increased 91 percent globally and increased 165 percent in developing countries in the 200-2015 period. To reduce the increase in resistance, various efforts have been made, including using natural ingredients as antibiotics as well as friendly antimicrobials.

Various studies have shown that the use of natural ingredients derived from plants is quite capable of inhibiting the growth of disease-causing microbes. Reported that there was antibacterial activity in red pomegranate leaves in inhibiting the growth of pathogenic microbes. Other research also shows that basil leaves [3]; dragon fruit skin extract [4]; aloe vera skin [5].

Research shows that fruit peel waste also has potential as an antimicrobial. This is interesting, because usually the use of fruit peels is limited as a mixture of natural fertilizers. The use of fruit peels which are actually waste has extraordinary benefits, especially in inhibiting the growth of pathogenic microbes. One of the most interesting fruit peel wastes is durian peel. Data from the Central Statistics Agency, durian harvest production in North Sumatra is 579,471 tons/year, resulting in durian skin waste of 376,656.15 tons/year. Durian skin if left unchecked will cause an unpleasant odor and if burned will cause air pollution. However, durian skin also has many benefits but unfortunately many people still don't know about it.

One of the plants that can be used as an herbal antibacterial drug is durian peel waste (*Durio zibenthinus* Murr.). Based on [6] durian skin contains compounds from the class of flavonoids, phenolics, alkaloids, steroids, saponins, and a few compounds from the terpenoid group. Apart from containing chemical ingredients that can be used as medicine, durian skin also contains various vitamins and also carbohydrates, fat, protein, fiber, calcium, phosphorus, folic acid, magnesium, potassium or potassium (K), iron (Fe), zinc, manganese (Mn), copper (Cu), carotene, thiamin, niacin, and riboflavin [7]. Durian skin contains high cellulose elements (50-60%), lignin content (5%), and low starch content (5%) so that it can be indicated as a mixture of processed food raw materials. as well as other products that are used [8].

In a previous study conducted tested the activity of the ethanolic extract of durian skin (*Durio zibethinus* Murr) against *Propionibacterium acnes* and *Staphylococcus aureus* bacteria with the orientation of the MIC value on *Propionibacterium acnes* bacteria obtained was 10% with an inhibitory zone area formed of 7.5mm ±0.4mm. While the MIC value for Staphylococcus aureus bacteria obtained was 10% with the area of the inhibition zone formed of 8.11mm ±0.4 mm [9]. Based on the test results obtained, it can be seen that durian peel extract is able to inhibit the bacteria *Propionibacterium acnes* and *Staphylococcus aureus*.

Based on the above background which is based on previous research, with the potential of durian fruit peel containing secondary metabolite compounds that have antimicrobial potential on several types of pathogenic microbes, it is necessary to do further research to test the potential of ethanol extract of durian fruit peel against various types of bacteria. other pathogenic microbes.

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Methodology

This research was conducted in the microbiology laboratory, Department of Biology, Faculty of Mathematics and Natural Sciences, State University of Medan. The time of this research is planned to start from March – October 2022.

Tools and materials

The tools that will be used in this study include spray bottles, autoclaves, petridishes, tweezers, bunsen, label paper, plastic, paper disks, calipers, loop needles, test tubes, Erlenmeyer, brown cover paper, rope, analytical balance, masks and scissor.

The materials used in this study were 96% ethanol, 70% alcohol, spirits, NA media, PDA media NB media, PDB media, Emba media, distilled water, DMSO, chloramphenicol, pathogenic microbial cultures, durian rind, pathogenic microbial cultures.

Sample preparation

Durian fruit skin (*Durio zibethinus* Murr) used in this study is durian fruit skin which has good quality. Durian skin which is included in good quality is not rotten, still fresh, and there is no fungus on the skin. After collecting samples of durian skins taken from durian traders then wet sorting is carried out, the purpose of this wet sorting is to select good and not rotten durian skins.

Making ethanol extract

Durian peel extract (*Durio zibethinus* Murr) was prepared by maceration method using 96% ethanol solvent. Durian rind simplicia was weighed as much as 500 grams put into a container and added 5 L of 96% ethanol solvent, left for 3-5 days while occasionally stirring. After the first extraction process, the filtrate is filtered, then the dregs is macerated again in the same way. The liquid extract that has been collected is then evaporated to obtain a thick extract. The extract was stored in a closed container before being used for further testing. Durian peel extract solution was made with various concentrations of 60%, 50%, 40%, to test the extract's antibacterial activity.

Antibacterial activity test

The antibacterial activity test was carried out using the agar diffusion method (Kirby-Bauer test) using paper discs. The media used in this test is NA media. Disc paper serves as a place to accommodate antibacterial substances. The diameter of the inhibition zone was measured by measuring the clear zone formed using a caliper

Results and discussions

Research to see the ability of the antibacterial activity of durian peel waste was carried out by testing the ethanol extract of durian peel waste on 3 types of test bacteria with various concentrations. The test bacteria used were *Bacillus cereus, Staphylococcus aureus* and *Pseudomonas aeruginosa*. Measurement of antimicrobial activity was carried out by agar diffusion by calculating the inhibition zones formed. Each measurement was carried out at three different concentration series starting from 40%, 50% and 60% with 3 repetitions each. Durian skin waste extraction process using ethanol solvent.

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Based on the results of the measurement of the antimicrobial activity test of the ethanol extract of durian peel waste which was tested on the 4 types of test bacteria, the results were obtained by looking at the diameter of the inhibition zone formed. Inhibition zone measurements were carried out after 1x24 hours of observation time, where the following results were obtained:

Tablel 1. Data on average inhibition zone diameter of durian waste ethanol extract

Bacteria	Concentration		
	40%	**50%**	**60%**
Bacillus cereus	8,60	10,00	11,30
Pseudomonas aeruginosa	9,93	11,63	12,30
Staphylococcus aureus	13,43	14,87	16,27

Inhibition zone measurements were carried out within 1 x 24 hours after observation. Based on the research data, it was found that the best concentration to inhibit growth for all types of pathogenic bacteria was at a concentration of 60%. Inhibition has been seen from the smallest concentration at a concentration of 40%. The research data is the average data obtained from three replications.

The ability of the ethanol extract of durian peel waste to inhibit the growth of pathogenic bacteria is possible because, based on the phytochemical tests that have been carried out, it shows that the durian peel waste contains tannins, alkaloids, triterpenoids, and flavonoids as antibacterial ingredients and saponins, substances that contain foam [10]. This is also supported by research results from Hatta [11] stating that durian durian skin contains high cellulose elements (50-60%), lignin content (5%), and low starch content (5%) so that it can be indicated as a a mixture of processed food raw materials and other products used. Metabolite compounds that have antibacterial properties are tannins, flavonoids, saponins, triterpenoids, alkaloids, and essential oils.

The antibacterial properties of tannins are thought to be due to their toxicity which can damage bacterial cell membranes, tannin astringent compounds can induce the formation of tannin bond complexes to metal ions which can increase the toxicity of tannins. The tannin mechanism is thought to shrink cell walls or cell membranes thereby disrupting cell permeability which results in cells being unable to carry out living activities so that their growth is stunted and they die [12].

Conclusion

The activity of the ethanol extract of durian peels showed activity starting at a concentration of 40%. Based on the results of the study, it can be concluded that the greater the concentration of the ethanol extract of durian peel, the greater the ability to inhibit the growth of pathogenic bacteria. The best concentration in inhibiting the growth of pathogenic bacteria is a concentration of 60%.

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Antioxidant, antibacterial activity and identification of bioactive compounds from the ethanol extract of gagatan harimau leaves (*Vitis gracilis* BL)

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Abstract. *Gagatan Harimau (V. gracilis BL) has been used for a long time by ethnic Karo people to treat stomach pain, diarrhea, tumors and strokes. Medicines derived from plants are usually easy to obtain, inexpensive, and have minimal side effects when compared to synthetic drugs. Traditional medicinal plants that are antioxidant and antibacterial are useful sources for treating infectious diseases caused by bacteria. This study aims to determine the antioxidant activity using the DPPH method. The antibacterial activity of the ethanol extract of V. gracilis leaves was measured using the disc diffusion technique and identification of the bioactive compounds using the GC-MS method. The results showed that the extract had a very strong antioxidant activity with an IC_{50} value of 42.69 ± 0.59 µg/ml. The inhibition zone of the ethanol extract against S. aureus, S. enterica, S. saprophyticus, and C. freundii ranged from 10.86-26.90 mm so they were categorized as moderate to very sensitive. Found as many as 23 bioactive compounds, some of them namely methyl ester hexadecanoic acid, phytol, and kaempferol. Based on the research results, the ethanol extract of V. gracilis BL leaves has great potential as an antioxidant and antibacterial agent.*

Keywords: gagatan harimau, *V. gracilis* BL, antioxidant, antibacterial, GC-MS.

Introduction

Infectious diseases caused by viruses, bacteria, and parasites are one of the main health problems in Indonesia. Infectious diseases are the biggest contributor to death in children. Based on 2019 data, the main causes of death are pneumonia and diarrhea [1].

Indonesian people use various ways to treat various diseases, including using traditional medicine. Data presented by the Central Statistics Agency in the period 2009-2012 shows that no less than 23% of Indonesia's population still chooses traditional medicine. Traditional medicine is applied due to various factors such as age, gender, education, income, and social capital [2,3,4].

Batak ethnicity is the original ethnic group in North Sumatra which consists of 5 sub-ethnic groups or often also called clans, namely Karo, Phakpak, Simalungun, Toba, and Angkola-Mandailing. According to [5] that the five Batak sub-ethnicities still use medicinal plants in maintaining their health, especially the Karo and Simalungun Batak ethnicities.

One type of plant that is still used to treat various types of diseases by the Karo Batak ethnic group is *V. gracilis* BL . The synonymous name of this plant is Ampelocissus gracilis (wall.) Planch [6]. The results of a field review, the dried leaves of this plant are available in Kabanjahe

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traditional markets for various medicinal purposes. Based on empirical experience carried out by the Karo Batak ethnicity, boiled water from the leaves of this plant is usually used to increase stamina and overcome various diseases [7]. The results of interviews conducted with the local community indicated that *V. gracilis* BL leaves are very suitable in combination with turmeric, guava leaves, and *Uncaria gambir* leaves to cure stomach aches. Furthermore, the leaves of this plant are trusted by the community as a medicine to increase energy, and lower back pain and are the main ingredient for making massage oil. However, scientific information regarding the efficacy of this plant is still very little. [8] revealed that the ethanol extract of *V. gracilis* BL leaves contains secondary metabolites such as alkaloids, glycosides, flavonoids, saponins and tannins which are able to restore gastrocnemius muscle cells in rats that are given maximum physical activity. The results of the phytochemical screening of the leaves of this plant also contain terpenoids [9].
Several research results show that alkaloids, glycosides, flavonoids, saponins, tannins, and terpenoids of various types of plants have antioxidant and antibacterial activities [10,11,12,13,14, 15]. The purpose of this study was to determine antioxidant activity, identify bioactive compounds and antibacterial ethanol extract of *V. gracilis* BL leaves against *S. aureus* ATCC 25923, *S. enterica* ATCC 14028, *S. saprophyticus* ATCC 49907, C. Freundii ATCC 8090.

Methodology

Sample collection and extraction of gagat tiger leaves

The research was conducted from March 2022 to July 2022. The leaves were taken from Tiganderket Village and Lau Baleng Village, Karo District, North Sumatra Province, Indonesia. The leaves are sorted first, then cleaned using clean running water and drained, then weighed and air-dried for 8 days. The dried leaves are then crushed into powder using a blender. The extraction method used was maceration using ethanol. The maceration method is based on a modification from [16] where as much as 200 grams is dissolved in 4 liters of solvent. Leave it for 6 days and stir occasionally. Filter using two layers of calico cloth, then filter again using Whatman paper no. 41 to get the filtrate. The filtrate was evaporated using a rotary evaporator at 40^0C. The extract results were stored in small bottles and put in the refrigerator at 4^0C.

GC-MS analysis

Identification of bioactive compounds was carried out based on [17,18] using an Agilent Technologies GC system with types GC-7890B and MS-240. Spectroscopic detection involved an electron ionization system (70 eV). Helium gas was used as the carrier gas with a flow rate of mL/min. The initial temperature is set in the range of 50-1500C. The amount of extract solution injected was 1 µl. Identification and characterization of bioactive compounds was carried out based on GC retention time. The mass spectrum is matched to standards available at the National Institute of Standards and Technology (NIST) database. The bioactivity of the compounds was identified using https://pubchem.ncbi.nlm.nih. Gov and web search engines.

Test the antioxidant activity of the DPPH method

The antioxidant activity of the extract against DPPH free radicals was measured according to the method of [19]. The extract solution in 2 ml methanol was added to a solution of 0.5 ml DPPH (1 mM in methanol). The mixture was shaken and left at room temperature for 30 minutes. Measure the absorbance at a wavelength of 515 nm. Percent inhibition of the sample is calculated based on the difference in absorption between the blank and the sample, namely:

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$$(\%) = [1-(As/A0)\times 100]$$

*A0 (Absorbant blank); As (Absorbance of the sample).

The test was carried out 2 repetitions, Quercetin was used as a comparison. IC_{50} was calculated from the graph of the attenuation percentage against the sample concentration.

Sample preparation for testing was carried out by weighing 4 mg of sample and dissolving it in methanol to obtain mother liquor with a concentration of 1000 ppm. Tests were carried out with variations in sample concentration to obtain concentrations in the test solution: 10 ppm (62.5 µL pipette from the sample solution); 50 ppm (pipetted 125 µL of sample solution); 100 ppm (250 µL pipette from sample solution); and 200 ppm (pipetted 500 µL of the sample solution).

Antibacterial Screening

The antibacterial properties of the ethanol extract of V. gracilis BL leaves was measured by observing the zone of inhibition using the disc diffusion technique based on [20]. A total of 100 µl of bacteria was inoculated on the surface of Muller Hinton Agar (MHA). After that, 6 paper discs with a diameter of 6 mm were dripped with extract solutions with different concentrations (100%, 80%, 60%, and 40%) until they diffused evenly. Chloramphenicol was used as a positive control and DMSO as a negative control. Inhibition zone data were analyzed using ANOVA at a 95% confidence level. If there is a difference between the treatments, a Tukey test was performed using the SPSS version 20.0 program.

Results and discussion

The chemical composition of *V. gracilis* BL leaves is presented in table 1. Based on the chromatogram presented in Figure 1, it shows the retention time (RT) and the peak height of the bioactive compounds present in these extracts. The ethanol extract of *V. gracilis* BL leaves contains 23 bioactive compounds.

Data on the antioxidant activity of the ethanol extract of *V. gracilis* BL leaves are presented in table 2. The IC_{50} value was much lower when compared to quercetin. However, the antioxidant activity is still very strong because it is still below 50 µg/ml.

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Table 1. Bioactive compounds from the ethanol extract of *Vitis gracilis BL* leaves

No.	Compound Name	Molecular formula	RT (min)
1	Methane, nitroso-	CH_3NO	1.391
2	2-Propanone, 1-hydroxy-	$C_3H_6O_2$	2.151
3	Methanamine, N-hydroxy-N-methyl-	C_2H_7NO	2.585
4	2,4-Dihydroxy-2,5-dimethyl-3(2H)-furan-3-one	$C_6H_8O_4$	4.503
5	3-(1-Methylethyl)-5-methyl-5-(2-oxopropyl)-2-isoxazoline	$C_{10}H_{17}NO_2$	6.384
6	2-oxo-propanoic acid, methyl ester	$C_4H_6O_3$	7.723
7	2,3-Dihydro-3,5-dihydroxy-6-methyl-4H-pyran-4-one	$C_6H_8O_4$	7.904
8	2-Methoxy-4-vinylphenol	$C_9H_{10}O_2$	12.137
9	Phenol, 2,6-dimethoxy-	$C_8H_{10}O_3$	13.078
10	Kaempferol	$C_8H_8O_4$	15.43
11	3,21-(Epoxy[2,4]hexadiynoxy)-5H,7H,19Hdibenzo[c,m][1,5,12,16]tetrao xacycloheptacosin-5,19-dione, 26,27,28,29-tetradehydro-8,9,10,11,12,13,14,15,16,17,25,30-dodecahydro-	$C_{37}H_{36}O_8$	15.575
12	beta.-D-Glucopyranose, 1,6-anhydro-	$C_6H_{10}O_5$	16.298
13	3',5'-Dimethoxyacetophenone	$C_{10}H_{12}O_3$	18.252
14	Benzaldehyde, 4-hydroxy-3,5-dimethoxy-	$C_9H_{10}O_4$	20.387
15	3,5-Dimethoxy-4-hydroxybenzyl Alcohol	$C_9H_{12}O_4$	21.472
16	Neophytadiene	$C_{20}H_{38}$	24.077
17	(2S,5R)-2-Isopropyl--5methylhept-6-en-1-ol	$C_{11}H_{22}O$	24.946
18	Hexadecanoic acid, methyl ester	$C_{17}H_{34}O_2$	25.85
19	Dodecanoic acid, methyl ester	$C_{13}H_{26}O_2$	27.225
20	9,12-Octadecadienoic acid, methyl ester, (E,E)-	$C_{19}H_{34}O_2$	29.035
21	11,14,17-Eicosatrienoic acid, methyl Ester	$C_{21}H_{36}O_2$	29.143
22	Phytol	$C_{20}H_{40}O$	29.396

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23	Octadecanoic acid, methyl ester	$C_{19}H_{38}O_2$	29.613

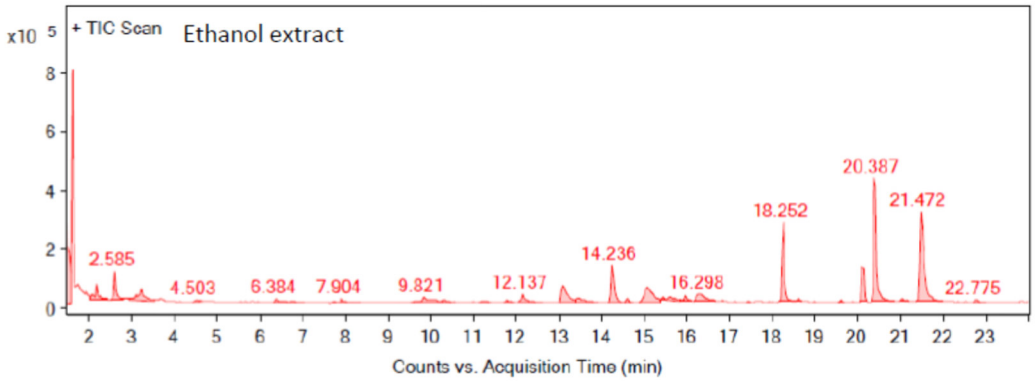


Figure 1. GC-MS chromatogram of the ethanol extract of *V. gracilis* BL leaves.

Table 2. Antioxidant activity of the ethanol extract of *V. gracilis* BL leaves

No	Extract	IC_{50} (µg/ml)
1	Quercetin	4,50±0,0
2	*Vitis gracilis BL*	42,69±0,59

The antibacterial properties of the ethanol extract of *V. gracilis* BL leaves against four microorganisms can be seen in table 3. All extract concentrations showed antibacterial activity on all bacterial strains with a range of inhibition zones between 10.86 – 26.90 mm. The highest inhibition zone was found at a concentration of 40% for *C. freundii*, namely 26.90 mm and the lowest at a concentration of 100% and 60% for S. aureus, namely 10.86. The concentration of 40% ethanol extract had the highest inhibition on four bacterial strains with very sensitive categories. There were no significant differences in concentrations of 100%, 80% and 60% extract in all bacterial strains except *S. Saprophyticus*. However, the inhibition zones was still lower when compared to chloramphenicol.

Table 3. Inhibition zone (mm) of *V. gracilis* BL leaf ethanol extract against four microorganisms

Concentration (%)	*S. aureus*	*S. enterica*	*S. saprophyticus*	*C. freundii*
100	16,63±1,19^{a}	10,86±0,35^{a}	12,36±0,72^{a}	15,79±0,70^{a}
80	15,96±0,15^{a}	12,13±0,40^{a}	13,26±0,45^{ab}	15,33±0,35^{a}
60	14,30±0,26^{a}	10,86±0,37^{a}	14,03±0,37^{b}	14,16±0,25^{a}
40	23,36±0,80^{b}	18,96±0,66^{b}	21,83±0,47^{c}	26,90±0,26^{b}
Chloramphenicol	31,22±1,49^{c}	29,94±0,75^{c}	44,83±0,44^{d}	33,89±1,17^{c}

* different letters show significant differences ($p<0,05$)

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Several chemical compounds contained in the ethanol extract of *V. gracilis* BL leaves have pharmacological activity. 2,4-Dihydroxy-2,5-dimethyl-3(2H)-furan-3-one has the potential as an antioxidant and flavor enhancer [21] [22]. 2-methoxy-4-vinyl phenol has antioxidant activity, is cytotoxic to HELA cell, anti-inflammatory, antimicrobial, and meat preservative [23] [24] [25] [26]. Benzaldehyde, 4-hydroxy-3,5-dimethoxy, or syringaldehyde have the potential as antioxidants, anti-inflammatories, and antidiabetics [257. 9,12-Octadecadienoic acid, methyl ester has the potential as an antioxidant, antimicrobial, anti-inflammatory, anticancer, hepatoprotective, and nematicidal [28] [29]. 3',5'-Dimethoxyacetophenone has the potential as an antioxidant and antimicrobial [30]. 11,14,17-Eicosatrienoic acid, methyl ester has the potential as anti-arthritis and anti-inflammatory [31]. Hexadecanoic acid, methyl ester, or palmitic acid have the potential as antioxidants, anticancer, anti-inflammatory, vasodilators, and antidiabetics [332 [33]. Dodecanoic acid, methyl ester, or lauric acid have potential as antimicrobials [34]. Beta-D-Glucopyranose, 1,6-anhydrous has the potential as an antioxidant, antimicrobial, and antidiabetic [35] [36]. Kaempferol has the potential as an antioxidant, anti-inflammatory, antihypertensive and cardioprotective [37]. Neophytadiene has the potential as an anti-inflammatory, cardioprotective, antipyretic, and antimicrobial [38] [39] [40]. Phenol, 2,6-dimethoxy has the potential as an antimicrobial and antioxidant, [41] [42]. Phytol has the potential as an antidiabetic [43].

Criteria for extract sensitivity to microorganisms based on inhibition were divided into four categories, namely insensitive (≤8.0 mm), moderate (8.0 – 14.0 mm), sensitive (14.0 – 20.0 mm), and very sensitive (≥ 20.0 mm) [44]. In general, the inhibitory power of the extracts was in the moderate to very sensitive category. The inhibition power of the extract at a concentration of 40% was categorized as very sensitive for *S. Aureus*, *S. Saprophyticus*, *C. freundii,* and sensitive for *S. enterica*. The results of this study are in line with the findings of [45] which stated that this plant extract has antibacterial activity against these four bacterial strains. The content of secondary metabolites such as flavonoids, alkaloids and tannins contained in is thought to have antibacterial activity. For example, tannins can react with proteins that make up the cell wall so that they have the opportunity to inhibit bacterial growth [46], and alkaloids can inhibit cell division in both gram-positive and gram-negative bacteria [47]. In addition to secondary metabolites, antibacterial activity is affected by the concentration of these plant extracts [48]. Antibacterial activity is also suspected due to the presence of bioactive compounds in this plant extract such as 2-methoxy-4-vinyl phenol, 3',5'-Dimethoxyacetophenone, Dodecanoic acid methyl ester, Beta-D-Glucopyranose 1,6-anhydrous, Neophytadiene and Phenol, 2 ,6-dimethoxy.

Several plants in the genus *Ampelocissus* have antioxidant and antibacterial activity, both in fruits, rhizomes and seeds. This activity is thought to be due to the content of flavonoids and phenols found in these plants. The IC_{50} value of the ethanol extract of *V. gracilis* leaves (42.69) was lower when compared to the methanol extract of *A. latifolia* leaves (738.80) and the methanol extract of *A. martini* rhizome (96.13) but higher when compared to the methanol extract of young fruit *A. martini* (41,50) [49] [50] [51]. In addition, the inhibition against *S. aureus* and *S. enterica* is higher if compared to *A. grantii* rhizome extract [52].

Conclusion

Based upon the results of this present study, it can be concluded that the ethanol extract of *V. gracilis* BL leaves has the potential as an antibacterial and antioxidant. Therefore, it is necessary to carry out further tests to determine the antibacterial activities as minimum inhibitory concentration (MIC),

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minimum bactericidal concentration and *in vivo* antioxidant activities as well as the isolation of bioactive compounds from the extract.

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Potential of medicinal plants in the forest of Bukum Village, Sibolangit district, Deli Serdang regency, North Sumatera province

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Abstract. *Medicinal plants include plants that are used as ingredients for traditional medicines, as starting materials, herbs, medicinal raw materials, or plants that are extracted and used as medicine. North Sumatra Province is the second largest producer of traditional medicinal herbs nationally, this situation proves that traditional medicinal plants in North Sumatra Province have economic value in the community. The types of medicinal plants used in the province of North Sumatra are Acoraceae, Alliaceae, Amaryllidaceae, Araceae, Arecaceae, Asparagaceae, Bromeliaceae, Costaceae, Cyperaceae, Marantaceae, Musaceae, Orchidaceae, Pandanaceae, Poaceae, and Zingiberaceae. The purpose of the study was to determine the types of medicinal plants used by the people of Bukum Village, Sibolangit District, Deli Serdang Regency, and to find out the benefits of medicinal plants used. The type of research used in this research is descriptive qualitative research with interviews, direct observation, and phytochemical screening/screening. Phytochemical screening to detect the content of secondary metabolites such as alkaloids, flavonoids, steroids, saponins, and tannins. Based on the results of the research, 26 species of medicinal plants were found in the Forest of Bukum Village, Sibolangit District, Deli Serdang Regency.*

Keywords: medicinal plants, traditional medicine, Bukum Village

Introduction

The tendency of people in Indonesia to turn to nature or "Back to Nature" has become a habit of life until now, especially to maintain a healthy body. In its use, it is generally known that traditional medicine is more effective because it has fewer side effects than the use of modern medicine. As an agricultural country, Indonesia has extensive plantation and agricultural areas as well as yards that can be planted with medicinal plants [1]. The number of plants used by the community to become traditional medicines is increasing. The types of medicinal plants used in the province of North Sumatra are *Acoraceae, Alliaceae, Amaryllidaceae, Araceae, Arecaceae, Asparagaceae, Bromeliaceae, Costaceae, Cyperaceae, Marantaceae, Musaceae, Orchidaceae, Pandanaceae, Poaceae,* and *Zingiberaceae* [2].

Bukum Village is one of the villages in Sibolangit District, Deli Serdang Regency. The diversity of plants in the Forest of Bukum Village is quite abundant, there are several types of plants that grow there. Among them are *Asteraceae, Araceae, Piperaecea,* and *Pteridophyta*. Currently, there are still many plants that exist in the Bukum Village Forest that have not been explored and their potential secondary metabolites are unknown. The results of this study are

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expected to add information on the potential of medicinal plants from the Bukum Village Forest which have not been explored and are expected to be further researched to uncover their potential and also proper processing.

Methodology

Materials and methods

This research was conducted in the Forest of Bukum Village, Sibolangit District, Deli Serdang Regency, and morphological identification was carried out at the Biology Laboratory, Faculty of Mathematics and Natural Sciences, State University of Medan. This research was conducted from January 2022 – March 2022.

The tools used in this study were a stationary, camera, large and small plastic scissors, a cutter, Bunsen, a test tube, a beaker, a dropper, gloves, filter paper, a furnace, a stirrer, an analytical balance, and a glass funnel. While the materials used in this study were distilled water, 2N HCL, Mayer reagent, Bouchard at reagent, Dragendroff reagent, mg powder, amyl alcohol (pentanol), Lieberman- Burchard reagent (acetic anhydride and concentrated sulfuric acid), ether, FeCl3 1%, spirit, 70% alcohol, medicinal plant samples, medicinal plant Simplicia, observation sheet, label paper.

The type of research used in this research is descriptive qualitative research with interviews, direct observation, and phytochemical screening/screening. Phytochemical screening to detect the content of secondary metabolites such as alkaloids, flavonoids, steroids, saponins, and tannins.

Results and discussion

Types of plants with potential medicine in the forest of Bukum Village

From the research that has been done, obtained 26 species of plants have medicinal potential in the Forest of Bukum Village (Table below).

Table 1. Types of plants with potential medicine in the forest of Bukum village

No.	Plant type	Family	Local name
1.	*Eupatorium inulifolium* Kunth.	Asteraceae	Lenga- lenga Begu
2.	*Clibadium surinamense* L.	Asteraceae	Lenga- lenga kambing
3.	*Impatiens platypetala* Lindl.	Balsaminaceae	Bunga sapa
4.	*Impatiens pyrrhotricha* Miq.	Balsaminaceae	Bunga Kiyung
5.	*Dendrocalamus asper* (Schult. & Schult. f.) Backer ex K. Heyne	Poaceae	Buluh mbelin
6.	*Clerodendrum chinense* (Osbeck) Mabb.	Lamiaceae	Sirembanua
7.	*Bischofia javanica* Blume.	Phyllanthaceae	Cingkam
8.	*Curcuma domestica* Valeton	Zingiberaceae	Kuning gersing
9.	*Curcuma aeruginosa* Roxb.	Zingiberaceae	Kuning tarbabana
10.	*Acorus calamus* L.	Acoraceae	Jerangau
11.	*Zingiber cassumunar* Roxb.	Zingiberaceae	Mburle/bengle
12.	*Orthosiphon aristatus* (Blume) Miq.	Lamiaceae	Kumis kucing
13.	*Psidium guajava* L.	Myrtaceae	Jambu Kelutuk
14.	*Cymbopogon nardus* L.(Rendle)	Poaceae	Serai jinabun
15.	*Vitis gracilis* Wall.	Vitaceae	Gagatan harimau
16.	*Strobilanthes crispus* L.	Acanthaceae	Kecembling
17.	*Piper betle* L.	Solanaceae	Sirih

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18.	*Justicia gendarussa* Burm.F.	Acanthaceae	Besi-besi
19.	*Nicotiana tabacum* L.	Solanaceae	Tembakau
20.	*Garcinia mangostana* L.	Clusiaceae	Manggis
21.	*Zingiber officinale* Roscoe	Zingiberaceae	Bahing gara, Jahe merah
22.	*Cocos nucifera* L.	Arecaceae	Coconut
23.	*Hibiscus rosa-sinensis* L.	Malvaceae	Kembang sepatu
24.	*Etlingera elatior* (Jack) R. M. Smith	Zingiberaceae	Cekala acid, kincung, honje
25	*Vitex trifolia* L.	Lamiaceae	Salagundi
26	*Allium cepa* L.	Liliaceae	Red Onion

The following is a picture according to the medicinal plants found in the village of Bukumplease, arrange the figures.

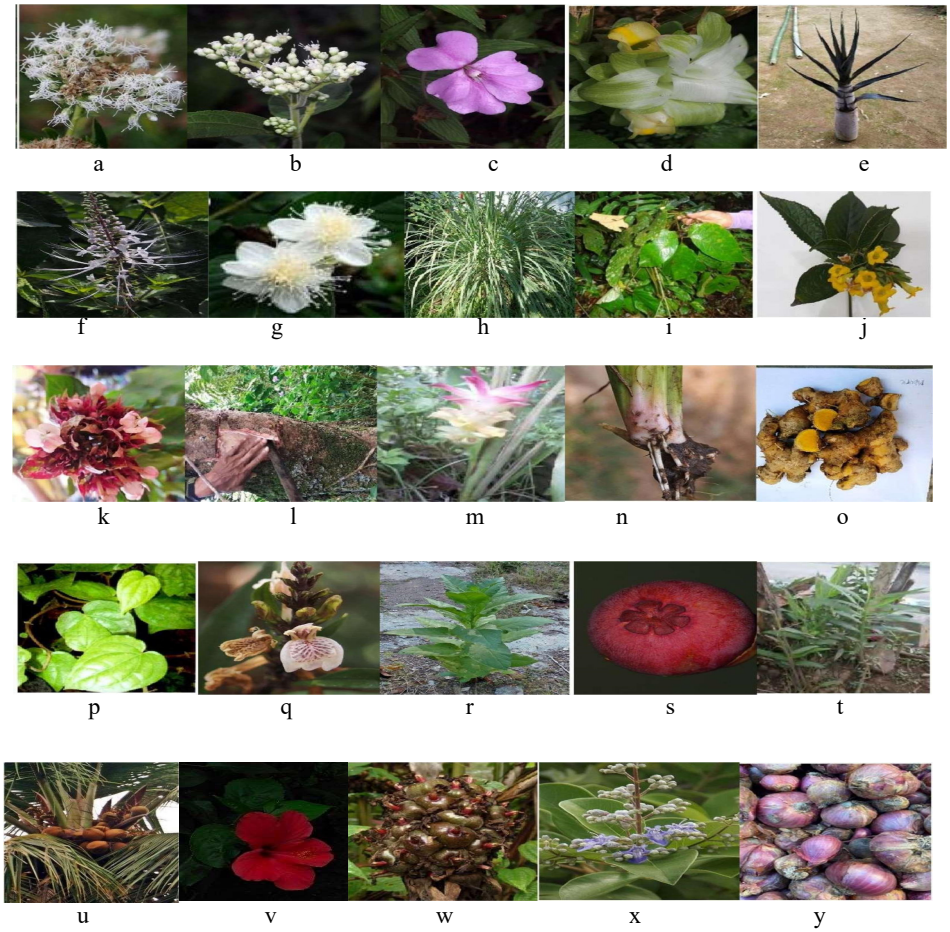


Figure 1. (a)*Eupatorium inulifolium* Kunth., (b) *Clibadium surinamense* L., (c) *Impatiens platypetala* Lindl., (d) *Curcuma domestica* Valeton, (e) *Dendrocalamus asper* (Schult. & Schult. f.) Backer ex K. Heyne, (f) *Clerodendrum chinense* (Osbeck) Mabb., (g) *Bischofia javanica* Blume., (h) *Curcuma aeruginosa* Roxb., (i) *Acorus calamus* L., (j) *Zingiber cassumunar* Roxb., (k) *Orthosiphon aristatus* (Blume) Miq., (l) *Psidium guajava* L., (m) *Cymbopogon nardus* L.(Rendle), (n) *Vitis gracilis* Wall., (o) *Strobilanthes crispus* L., (p) *Piper betle L., (q) Justicia gendarussa Burm.F., (r) Nicotiana tabacum* L., (s) *Garcinia mangostana* L., (t) *Zingiber officinale* Roscoe, (u) *Cocos nucifera* L., (v) *Hibiscus rosa-sinensis* L., (w) *Etlingera elatior* (Jack) R. M. Smith, (x) *Vitex trifolia* L., (y) *Allium cepa* L.

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Utilization of medicinal potential plants by the village community of Bukum

From 26 species with medicinal potential found and utilized by the Bukum Village Forest community, almost all of them use leaf organs in their utilization. The following is an explanation of the use of plants used to treat various diseases in the Bukum Village Forest.

Eupatorium inulifolium Kunth

In the area of Bukum Village, this plant is also known as lenga-lenga begu. According to their belief, the leaves of this plant can treat wounds by squeezing the leaves and placing them on the wound. Another use of wood is used for fuel. The leaves are used to treat diarrhea, digestive tract disorders, and diabetes mellitus [3].

Clibadium surinamense L.

In the area of Bukum Village, this plant is also known as lenga-lenga goat, this plant can be used to treat diarrhea by boiling the leaves and flowers then adding eggs, and then adding gambier and salt so that it is not too bitter to drink to people who are experiencing diarrhea or dysentery. In other treatments, the leaves are used to heal wounds, digestive tract disorders, diabetes mellitus, and fever.

Impatiens platypetala Lindl.

This plant is known as Bunga sapa in Bukum Village. It can be used as a param by squeezing the leaves, stems, and flowers until they release a liquid and then wrapping it around the body. Other uses as skin medicine, flowers are used as jaundice, and leaves as fever medicine.

Impatiens pyrrhotricha

This plant is known as Kiyung Flower. This plant can treat the itching. The plant parts used are stems, leaves, and flowers.

Dendrocalamus asper (Schult. & Schult. f.) Backer ex K. Heyne

This plant, known as Reed Mbelin, can treat fractures. The roots of this plant, also known as sliced bamboo shoots, are then placed where the bones are broken and then wrapped with a cloth. The content of the Mbelin reed can soften the bones so that if you put the bamboo shoots wrapped in cloth, it can bring the bones back together.

Clerodendrum chinense (Osbeck)

Known as Sirembanua, it can treat stomach aches, by kneading the leaves and stems. This plant can also treat asthma, skin diseases, rheumatism, back pain, jaundice, cough, malaria, sprains, and fractures, activity as an antioxidant, antiseptic, and anti-implantation. Besides that, this plant also has the name Jasmine Susun Papua (Socfindo Conservation).

Bischofia javanica Blume

Known as Cingkam, it can treat diabetes and ulcer disease by boiling the leaves and bark and then drinking it to sick people.

Curcuma domestica Valeton

The way the rhizome/tuber is chewed and then sprayed. In addition, it is used as a rhizome drug for diarrhea, coughing, liver disorders, hemorrhoids, improving blood circulation, chest pain, cataracts, skin pain, tuberculosis, inflammation, and rheumatism.

Curcuma aeruginosa Roxb.

The way rhizome/tuber is chewed and then sprayed. In addition, it is used as a rhizome drug for diarrhea, coughing, liver disorders, hemorrhoids, improving blood circulation, chest pain, cataracts, skin pain, tuberculosis, inflammation, and rheumatism.

Acorus calamus L.

This plant known as Jerangau is used for all kinds of medicine, one of which is colds by

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chewing the rhizome and then spraying it. The people of Sumatra in the middle of the rhizome use it as an ingredient to treat stroke. The rhizome is used to treat fever, cough, tuberculosis (TB), birth, headache, asthma, and malnutrition.

Zingiber cassumunar Roxb.

This plant, known as Mburle / Bengle can treat colds by grinding the rhizome and then boiling it. The rhizome can treat wounds that take a long time to heal, heal childbirth, diet, hepatitis medicine, diarrhea, and antidote [4].

Orthosiphon aristatus (Blume) Miq.

This plant is known as the cat's whiskers according to the belief of the people of Bukum Village, the plant can treat back pain, and urinary tract infections by boiling the leaves and then drinking. In addition, this plant can also treat urinary stones, the stems and leaves are boiled and the boiled water is drunk to clear the stones that have formed, besides the leaves are used to cure hypertension and kidney disorders.

Psidium guajava L.

Known as guava kelutuk according to the belief of the people of Bukum Village, it can treat diarrhea, as an antioxidant by boiling the leaves. Psidium guajava L. leaves can also treat respiratory tract disorders and diabetes mellitus.

Cymbopogon nardus L.(Rendle)

Known as lemongrass jinabun, the leaves and stems are used as one of the ingredients for making Karo oil. Karo oil can be used to treat various diseases such as sprains.

Ampelocissus filipes Planch

Known as gagatan tiger, it is used as a strong medicine or stamina. By boiling the leaves and then drinking, feeling the benefits for 3 weeks then can make us strong to run marathons.

Strobilanthes crispus

Known as Kecembling is used as a strong drug. By boiling the leaves and then drinking for 1 week, it can make us strong to run marathons.

Piper betle L.

Known as betel, this plant can strengthen teeth by chewing. Betel leaf plus gambier plus lime and added belo and then chewed. Piper betle L. leaves can also treat fever and wounds. In addition, it can also treat eye. infections, stomach pain, and toothache.

Justicia gendarusa Burm. F

In Bukum Village, this plant is known by the name of iron, according to them it can be used as a medicine for fever and rheumatism. By chewing the leaves. Other treatments include coughs, asthma, headaches, malaria, earaches, allergies, anti-parasites, postpartum and other uses as house fences and ornamental plants.

Nicotiana taubacum L

This plant is one of the ingredients for making cigarettes and also as a medicine for inflammation, polyps, insect and snake bites, headaches, diarrhea, cataracts, ordinary wounds and burns, fever, hair loss growth, hernia and malaria.

Garcinia mangostana L.

Known as the mangosteen, it can be used to lower cholesterol levels by means of ripe mangosteen rind (red skin) boiled and then drunk to people who suffer from cholesterol.

Zingiber officinale var. Rubrum

Known as red ginger can relieve pain by chewing the rhizome and then spraying it where it hurts. In addition, the rhizome is also used as a medicine to reduce inflammation, fight cancer cells, and treat gastric disorders.

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Cocos nucifera L.
Known as coconut, according to the belief of the people of Bukum Village, it can be used to treat kidney disease by adding coconut water (yellow) and silver coins and drinking it. In addition, the fruit, stem, and root of Cocos nucifera L. are used to treat fever. Roots and fruits cure tuberculosis, toothache, ulcers, sprains, fractures, and diabetes mellitus.
Hibiscus rosa-sinensis L.
Known as hibiscus to treat fever and cough. The leaves and flowers are kneaded to secrete mucus and then placed all over the body. Hibiscus rosa-sinensis L. leaves can also treat inflammation, and headaches, restore regularity of the menstrual cycle, various skin diseases, gonorrhea and diarrhea.
Etlingera elatior (Jack) R. M. Smith
In Bukum Village, it is known as cikala acid or kincung, it can treat diarrhea, fruit is blended, and then drunk. In addition, the leaves treat coughs and fever, the stems are sick with tuberculosis, and the rhizomes can treat rocks.
Vitex trifolia L.
Known as Salagundi, it is used to treat skin itching, sore eyes, and coughs by boiling the leaves, fruits, and seeds and then drinking the water. Other uses are as a medicine for fractures, laxatives, rheumatism, swollen testicles, tuberculosis, asthma, hemorrhoids, and liver function disorders, and leaves are used as drugs for hypertension, digestive tract disorders such as tuberculosis, and kidney disorders. Apart from being a medicinal plant, this plant is also used as an ornamental plant.
Allium cepa L.
In Bukum Village, known by the name shallots, the tubers can lower blood pressure. In addition, tubers are used to cure fever, wounds, diarrhea, ulcers, stomach pain, digestive tract disorders, and high cholesterol.

Content of secondary metabolites in medicinal potential plants used bthe Bukum village community
From the results of the phytochemical screening, the content of secondary metabolites was obtained in samples of potential medicinal plants found in the forest of Bukum Village.
Lenga -Lenga Kambing (Clibadium surinamense L.) (Leaf)
Based on the results of the research that has been carried out, the alkaloid test, namely bouchardat and flavonoid test, showed positive results and the tannin test was positive, while dragendroff, mayer, terpenoids, and saponins showed negative results.
Lenga -Lenga Begu (Eupatorium inulifolium Kunth.) (Leaf)
The alkaloid test, namely bouchardat, positive flavonoid test, positive saponin, and tannin test, while the alkaloid test, namely dragendroff, mayer, and terpenoids, showed negative results.
Bunga Sapa (Impatiens platypetala) (Leaf)
The alkaloid, Bouchardt, terpenoid and tannin tests were positive, while the dragendroff and mayer alkaloids, flavonoid, and saponin tests were negative.
Bunga Kiyung (Impatiens pyrrhotricha) (Leaf)
The terpenoid test showed positive results while the mayer, dragendorf, and bouchardat alkaloids, flavonoids, saponins, and tannin tests were negative.
Cingkam (Bischofia javanica) (Stem)
Tests for Bouchardt and Dragendroff alkaloids, flavonoids, saponins, and tannins showed positive results while mayer and terpenoids showed negative results.

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Cingkam (Bischofia javanica) (Leaf)
Flavonoid, terpenoid, saponin dan tannin menunjukkan hasil positif sedangkan alkaloid yaitu mayer, dragendroff dan bouchardat menunjukkan hasil negative.
Sirembanua (Clerodendrum chinense) (Leaf)
Flavonoids, terpenoids, saponins and tannins showed positive results while alkaloids namely mayer, dragendroff and bouchardat showed negative results.
Kuning Gersing/Kunyit (Curcuma domestica) (Rhizome)
The alkaloid test, namely bouchardat and saponins, showed positive results, while the mayer and dragendroff alkaloid tests, negative flavonoids, negative terpenoids, and tannins showed negative results.
Kuning Tarbabana (Curcuma aeruginosa) (Rhizome)
Tests for alkaloids namely bouchardat, terpenoids and saponins showed positive results, while tests for alkaloids mayer and dragendroff, flavonoids, and tannins showed negative results.
Jeringau (Acorus calamus) (Rhizome)
The alkaloid test, namely bouchardat and terpenoid, showed positive results, while the alkaloid test, namely dragendroff and mayer, flavonoids, saponins, and tannins, showed negative results.
Mburle/Bengle (Zingiber cassumunar) (Rhizome)
The alkaloid test, namely boucharda and saponin, showed positive results, while the alkaloid test, namely mayer, and dragendroff, flavonoids, terpenoids, and tannins, showed negative results.
Serai (Cymbopogon nardus) (Stem)
The dragendroff and bouchardat alkaloid tests, flavonoids, saponins and tannins showed positive results, while the alkaloid tests, namely mayer, and terpenoids, showed negative results.
Kumis Kucing (Orthosiphon aristatus) (Leaf)
The dragendroff and bouchardat alkaloid tests, flavonoids, saponins, and tannins showed positive results, while the alkaloid tests, namely mayer, and terpenoids, showed negative results.
Jambu Kelutuk (Psidium guajava L.) (Leaf)
Alkaloids test, namely bouchardat, terpenoids, saponins, and tannins showed positive results while flavonoids, Dragendroff, and Mayer alkaloid tests showed negative results. Alkaloids are one of the most secondary metabolites that contain nitrogen atoms. Alkaloids are efficacious as anti-diarrhea, anti-diabetic, anti-microbial, and anti-malarial. However, there are some alkaloids that are toxic so it is necessary to identify the alkaloid group compounds whose benefits can be known [5]. Alkaloids also have effects in the form of triggering the nervous system, raising blood pressure, and reducing pain, and antimicrobials, sedatives, and drugs for heart disease [6]. Flavonoids are one type of component contained in vascular plants. Flavonoids are known to have properties such as antioxidants, anti-inflammatory, and anti-allergic and can inhibit the oxidation of LDL (Low-Density Lipoprotein)[7]. Saponins have the effect of reducing the risk of atherosclerosis because of their ability to bind cholesterol. Saponins are also efficacious as antimicrobials and external wound drugs because they can stop blood on the skin.

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Conclusion

Obtained 28 species of plants with medicinal potential in the Forest of Bukum Village. The content of secondary metabolites of plants used as medicine by the community in the Forest of Bukum Village consists of 5 tests, namely 11 samples of plant parts containing Alkaloids, 6 samples of plant parts containing Flavonoids, 8 samples of plant parts containing Terpenoids, 10 samples of plant parts containing Saponins and 9 samples of plant parts contain tannins. The most used plant parts/organs are leaves. Leaves are plant organs that are easy to process and easy to find. There are ways of processing that are boiled, ground, and eaten directly. The leaves also have many properties in treating many diseases such as cholesterol, medicine for aches, fever, cough, tinea versicolor, and wound medicine.

Acknowledgments

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Phytoremediation of mercury waste (Hg^{2+}) using plant vetiver (*Vetiveria zizanioides)* with concentration variation

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Abstract. *One method of handling polluted land due to waste contamination is phytoremediation. This study aims to examine the effect of planting vetiver (Vetiveria zizanioides) on the phytoremediation of waste contaminated with mercury (Hg) to reduce the impact of environmental pollution. This research was carried out for three months in the Greenhouse of the Faculty of Mathematics and Natural Sciences, Medan State University, and the Laboratory of the Center for Research and Standardization in Medan City. This type of research is an experimental study with a completely randomized design. The number of treatment combinations consisted of 3 variations of synthetic waste contamination concentrations with 2 repetitions of the test. From the results of the study, it was found that vetiver plants were able to absorb mercury metal in planting media contaminated with synthetic waste, which was the highest at 15.68 mg/Kg during 12 days of exposure. The addition of compost to the planting medium as a stimulant is considered capable of increasing the ability of plants to withstand pollution by the heavy metal mercury. Accumulation of heavy metal mercury (Hg) by vetiver plants (Vetiveria zizanioides) increased with increasing phytoremediation time.*

Keywords: phytoremediation, Vetiveria zizanioides, synthetic waste, mercury

Introduction

Changes in the environment around industrial areas can occur at any time so effective waste management is an indicator of the sustainability of industrial operations. One of the impacts of environmental damage caused by industrial activities is residual material or waste originating from the production process [1]. One type of industrial waste that has considerable potential to increase the number of contaminants in the environment is waste containing heavy metals such

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as mercury (Hg). In ongoing silver and gold mining activities, several other elements are often found that are contained and dissolved in mining exploitation, these elements include tin, iron, mercury (Hg), copper, zinc, and also nickel [2].

Waste products from industrial activities that contain heavy metals can have an adverse effect on the environment due to the toxic elements contained therein. These wastes are generally disposed of and flowed into ditches, ditches, ponds, or rivers. Toxic waste containing heavy metals will contaminate the surrounding environment. Metals can cause harm to live things. This can occur when a number of metals pollute the environment. Certain metals will be very dangerous if found in high concentrations in the environment (in the water, soil, and air environment) because these metals have characteristics that can damage the tissues of living things [3].

Heavy metal mercury (Hg) is a type of pollutant that has received special attention from the public and the government because it has strong toxic properties compared to other heavy metals. Mercury from the next waste will turn into methylmercury due to natural processes. If the methyl mercury compound enters the human body through the medium of water, it can cause poisoning as was experienced by the victims of the Minamata Tragedy [4]. Mercury can accumulate and remain in living things for a long time as a poison. Mercury has a residence time(residence time) of thousands of years that can settle in sediments and enters a very damage environment in the area and accumulates in the bodies of living things through the respiratory, skin, and digestive tract so that it can result in death [5].

Today, there are many industries found illegally producing polluting waste, especially mercury, which produces waste in quantities that exceed the standard standards, which can cause pollution to the environment and pose health risks to mining so the area is prone to landslides and floods. This shows that environmental problems arising from metal mercury pollution must be addressed immediately, one of which is by preventing increasing pollution and mitigating the effects of pollution, as well as repairing natural damage at the site and its surroundings with environmentally friendly waste management techniques towards sustainable development humans. As was the case reported by Saturi at Mongabay (2014) it was found that laboratory test results of gold processing wastewater in the Mandailing Natal Regency area contained chemical substances such as mercury, lead, arsenic, cadmium, copper, nickel, -and zinc which was at the threshold quality standards. Data from tests carried out by the ITM Chemical Engineering Student Forum stated that the mercury levels removed reached 1.22 mg/l and the latest test conducted by the author in 2021 on the mercury content in mining waste at Mandailing Natal was 0.

(Holik in Antara Sumut (2019) reports that it is suspected that mining activities in the Mandailing Natal Regency area use mercury-type chemicals in the process of separating gold ore from rocks and indiscriminate disposal of mining waste which has an impact on human health. This can be seen by the presence of babies born with abnormal conditions around mining sites who are diagnosed with congenital defects such as omphalocele, Anencephaly, Cyclopiaand Gastroschisis.In addition to the deposition of mercury waste in the environment which endangers public health, the rise of mining activities using heavy equipment is also assessed. Environmentally friendly mercury waste pollution is by applying bioremediation techniques using plants or what is known as phytoremediation. Phytoremediation is a remediation technique using plants to move, stabilize, destroy or remove pollutants in the form of both organic and inorganic compounds found in the environment [8].

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Phytoremediation using the vetiver plant (*Vetiveria zizanioides*) has been recognized as very effective in reducing heavy metal waste pollution through its root system. This plant is able to withstand extreme soil conditions including areas contaminated with heavy metals. According to Badu (2018), the use of the vetiver plant (*Vetiveria zizanioides*) and bacteria can reduce oil and grease levels by 50-87% and oil content by 22-64% which pollute the aquatic environment. The results of research conducted by Wakano (2015) regarding the potential of vetiver plants in rehabilitating soil polluted by heavy metal lead ranged from 71.08% - 73.71%.

Based on research conducted by Triastuti (2011), the use of vetiver plants on mercury-contaminated land in ex-TPA land found the highest accumulation of mercury metal (Hg^{2+}) in the roots at a concentration of 6 mg/kg which was 0.698 mg/kg for planting media in the form of 100% polluted land. Based on the explanation above, this study aims to examine the effect of planting vetiver plants (*Vetiveria zizanioides*) on the phytoremediation of mercury waste with variations in the waste concentration used to increase the ability of plants to reduce the impact of environmental pollution.

Methodology

Materials

The materials used in this research areVetiveria zizanioides, aquabidest (H_2O), nitric acid (HNO_3), $HClO_4$ (perchloric acid), aluminum foil, filter paper, mining waste, synthetic mercury (Hg) waste, and tissue. The tools used in this study were SSA variant AA240ES, oven, electric bath, analytical balance, porcelain cup, desiccator, and poly bag size 3kg.

Methods

The research procedure was carried out in 4 (four) stages, namely preparation of planting media, plant acclimatization, phytoremediation, and analysis of mercury content.Preparation of Planting Media. The planting medium used is a soil mixture of 70% + 30% compost. Soil is then put on poly bag research with a volume of 3 kilograms. The addition of compost to the phytoremediation process carried out in this study acts as a stimulant for the absorption of Hg heavy metals so that plants are able to stimulate microbial activity found in compost and soil to degrade metals. Plants play a role in removing proteins, organic acids, and other compounds needed by microbes in the roots which is called an exudate. This exudate then serves to attract microbes in the soil so that they approach plant roots, which is known as chemotaxis. The metals absorbed by the plant roots will then be passed on to other plant tissues such as plant stems and leaves.

Plant Acclimatization. Plant acclimatization is done by placing the plants inside a poly bag for 30 days and isolating it in the greenhouse to reduce pollution allowing vetiver root crops(Vetiveria zizanioides) to adapt to new growth conditions. Phytoremediation.After acclimatization is complete, contamination of the planting medium using synthetic mercury (Hg) waste with a predetermined concentration variation of 10 mL in each poly bag. Every day at 08.00 WIB watering is carried out.Waste contamination was carried out for 12 days and sampling was carried out on days 4, 8, and 12 during exposure. The concentration of waste used in this study are

Q1 :	0,5 ppm man-made waste
Q2 :	1.5 ppm man-made waste
Q3 :	5 ppm man-made waste

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Analysis of Mercury Content Analysis of plant content (concentration) after being given treatment was carried out on days 4, 8, and 12. Each segment of the test plant consisted of roots, stems and leaves cleaned and cut into small pieces. The samples were then cooked in an oven at 105°C for 2 hours until the weight was constant, then weighed again to ensure a constant weight. On an analytical balance, the dry sample is weighed up to 5 grams, then 25 mL of aquabidest and 5 mL of HNO are added. A white precipitate was produced after heating the sample solution to a volume of 10 mL. After that, 1 mL of HClO was added to the sample, which is then filtered into a 100 mL volumetric flask and pressed with aquabidest until the meniscus is reached. Sample measurements were carried out using AAS.

Results and discussion

Results

Based on the research that has been done it was found that the vetiver plant (Vetiveria zizanioides) is capable of accumulating heavy metal mercury (Hg) sourced from mercury synthetic waste. Preliminary analysis of mercury (Hg) concentrations on vetiver plants (Vetiveria zizanioides) on day 0 before being given treatment can be seen in the following Table 1.

Table 1. Hg concentration in vetiver plants (*Vetiveria zizanioides*) 0th day

Plant Type	Hg Concentration	
	Mg/L	Mg/Kg
Vetiveria zizanioides	0.0013	0.2555

Based on the table it can be seen that The vetiver plant that will be used in the study already contains mercury of 0.2555 mg/Kg before being given treatment in the form of exposure to synthetic mercury waste. Based on Peterson and Alloway (1979) in Darmono (1995) this can occur due to the natural content of mercury contained in the soil, with an average content of 0.003-g/g at a non-population range of 0.01-0.3 which is then absorbed by plants during cultivation in nature.

Mercury (Hg) concentration analysis against vetiver (Vetiveria zizanioides) which has been contaminated with mercury synthetic wastewater for 12 days of exposure can be seen in Table 2 following.

Table 2. Hg concentration in vetiver plants (*Vetiveria zizanoides*) 12th days

Waste Concetration	Hg Concentration	
	mg/L	mg/kg
0.5 ppm	0.298	5.96
1.5 ppm	0.0552	11.04
5 ppm	0.0784	15.68

Based on the data contained in Table, on the 12th day (after phytoremediation) it can be seen that significant mercury absorption was found in plants. The mercury concentration was 5.96 mg/Kg in 0.5 ppm waste and 11.04 mg/Kg in 1.5 ppm waste and 15.68 mg/kg at 5 ppm concentration. The highest concentration of mercury absorbed after 12 days was found in plants with 5 ppm waste contamination which is equal to 15.4245 mg/Kg. The concentration rate of mercury (Hg) that can be absorbed by vetiver plants (*Vetiveria zizanioides*) contaminated with synthetic waste during 12 days of exposure can be seen in graphic image 1 following.

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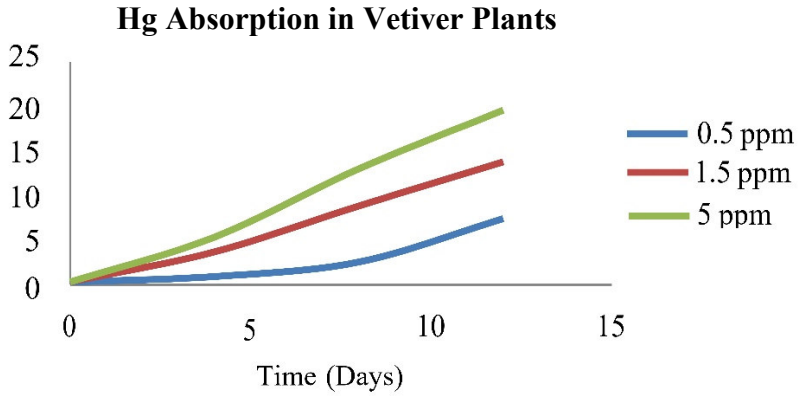


Figure 1. The graph on metal absorption in vetiver plants (*Vetiver zizanoides*)

Graphic image 1. shows the results of testing the concentration of mercury (Hg) on vetiver plants (Vetiveria zizanioides) that have been exposed to synthetic waste. The concentration of Hg in plants with the highest amount was found in the waste concentration of 5 ppm on day 12, which was 15.68 mg/Kg. In the graph, it can be seen that in plants contaminated with synthetic waste, absorption seems to increase with the length of contact time.

Discussion

Not all plants have the ability to adapt to an environment polluted by heavy metals and accumulate these heavy metals. Plants that can accumulate heavy metals such as vetiver have varying levels of sensitivity. Heavy metals such as mercury (Hg) are absorbed by plant roots as dissolved ions such as nutrients that enter with the flow of water. This plant then forms a reductase enzyme in its root membrane which functions to reduce metals. Mercury (Hg2+) is transported from the roots to various regions of the plant body through transport networks, especially the xylem and phloem, using metal bonds by chelate molecules (binding molecules) which increase the efficiency of transportation [11]. The mercury will then collect in the roots, stems, and leaves of vetiver plants (Vetiveria zizanioides). Heavy metals such as mercury (Hg2+) are stored by vetiver plants when they form complex compounds with elements and other substances such as phytochelatin, which consists of several amino acids such as cysteine and glycine. Phytochelatin is formed together with enzymes that synthesize glutathione synthetase and in the plant body, phytochelatin makes complex compounds with heavy metals and acts as a heavy metal detoxifier. Metal detoxification by phytochelatin is carried out through a metal binding process, after which the metal is transferred to the plant vacuole for storage [12].

Metal binding with chelating chemicals will then enter the water and nutrient absorption system through plant root hairs. Chelation of mercury with chelating chemicals can produce complex salts containing mercury attached to the S (sulfur) group of the amino acid phytochelatin. Through the apoplastic transport network, complex chemicals and the resulting salts will be absorbed and translocated to other plant organs with the heavy metal mercury being transferred from outside into the cell across the membrane. Because the mercury molecule is so large that it requires a protein or enzyme to pass through the membrane, this transport process cannot be carried out by conventional diffusion. Protons are then pumped out of the membrane to the apoplast area using ATP which results in a difference in the concentration of protons inside and outside the membrane. On day 12 after exposure, the vetiver plant (*Vetiveria zizanioides*)

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shows signs of poisoning Among them, the leaves of the plant turn yellow and some leaves curl and wrinkle. This is due to the impact of the toxic metal mercury (Hg) which inhibits plant metabolic processes. Because the plants used in the phytoremediation process have never been watered, one of the variables that limit plant metabolism is due to lack of water and other factors are lack of oxygen and temperature fluctuations.

Conclusion

Based on the research conducted, it can be concluded that the vetiver plant (Vetiveria zizanioides) has the ability to reduce mercury metal contamination (Hg^{2+}) by 15.68 mg/Kg in synthetic waste contamination during 12 days of exposure.

Acknowledgments

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Effect of lime essential oil on massage on the counting of leukocyte and thrombocyte after exercise for athletes

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Abstract. *During physical exercise, relative hypoxia occurs so that the amount of oxygen in the tissue decreases, this has the potential to form free radicals. Antioxidants will help eliminate these free radicals. The lime essential oil contains flavonoids that act as antioxidants. The use of lime essential oil in massage immediately after physical exercise is expected to affect the count value of leukocytes and platelet. This is an experimental study with a pre and post-test design group design. Participants are 30 male athletes, aged 20-22 years. Participants were divided into 3 groups, the exercise group (P1), namely the athlete group who did the exercise and was not given a massage; the exercise massage group (P2), namely the group of athletes who did exercises and were given a massage with ordinary lotion as a topical oil; the citrus exercise massage group (P3) is a group of athletes who do exercises and are given a massage with lime essential oil as the topical oil. There was a difference between each group in the leukocyte count, but there was no significant difference in the platelet value between each group. The use of lime essential oil in massage immediately after regular physical exercise can affect the production of free radicals indirectly which is characterized by changes in the leukocyte count.*

Keywords: exercise, leukocyte, lime essential, massage, and thrombocyte

Introduction

The HEMATOLOGICAL system, which includes the erythrocyte, leucocytes, and thrombocyte, can undergo a multitude of physiologic changes in response to exercise [1]. Alterations in the immune system's physiological cells, such as those seen in the leukocyte [2]. According to Hazar and Ylmaz (2008), alterations in the immune system are defined by leukocytosis and the activation of leukocytes, as well as the production of inflammatory mediators and damage to THE tissue [3]. By clinging to the site of the injury or wound and aggregating with one another, thrombocytes are able to make a contribution to the process that controls bleeding. When THROMBOCYTES are present in the blood, a process that takes place during normal circulation and is referred to as primary hemostasis takes place, this process stops bleeding [4].

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Muscles have a great need for oxygen since intense and continuous energy expenditure is required during exercise. Relative hypoxia causes a decrease in tissue oxygen during prolonged and intense physical exertion. Moderately strenuous activity has the potential to generate an abundance of free radicals, which could lead to oxidative stress [5].

Massage is one of the treatments that athletes frequently employ, and its goal is to decrease muscular injury that has been brought on by strenuous training or competition. The physiological consequences of massage include stress relief, improved circulation, lymphatic drainage, nervous system stimulation, and improved venous return. Therefore, massage may have a moderating effect on the formation of free radicals [6]. The application of lotion as a form of topical massage therapy has been the focus of a number of studies. The lime essential oil was used as one of the topical substances in this study for massage treatment, which is one of the key differences from previous research. Due to its bioactive components, including linalool and linalyl acetate, the lime essential oil has a pharmacological impact that can have a calming influence on the body and mind.

Lime essential oil is rich in flavonoids, which are chemicals that have antioxidant properties and are found in the oil. Flavonoids have the ability to have a preventative effect against the damage that is caused by the oxidative stress that is caused by physical activity. This is because flavonoids are able to combat free radicals [7].

Methodology

Ethical approval

This research procedure has been approved by the Ethics Committee for the Implementation of Health Research at the University of North Sumatra (reference number: 523/KEPK/USU/2022).

Participant

Boxing athletes, no smokers and ranging in age from 17 to 19 years old, make up the group of 30 participants.

Protocol exercise

Participants were split into three groups: the exercise group (P1), which performed physical activity but did not receive massage; the exercise massage group (P2), which also performed physical activity but received a **message** using regular lotion as the topical oil; and the exercise massage lime group (P3), which performed physical activity but received a massage using lime essential oil as the topical oil. The exercises are given according to the training program from the trainer with a frequency of 3 times a week for 4 weeks. Massage is given to the arms and legs, every 30 minutes after exercise. Before and after treatment, leukocytes and pthrombocyte were examined.

Statistical analysis

The data were analyzed using either one-way analysis of variance (ANOVA) or a P-value less than 0.05 for statistical significance.

Results and discussion

The results of the Anova test analysis showed (table 1) that there was a significant difference in the average leukocytes ($p = 0.000$) after exercise in all 3 groups. Based on the data showed that there was an increase in the average leukocytes after exercise in group P1 by 4.37%, there was a

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decrease in the average leukocytes after exercise in group P2 by 7.29%, there a decrease in the average leukocytes after exercise in group P3 by 8.47%, This means that leukocytes in groups P2 and P3 there was a decrease compared to group P1. Based on the data showed that there was an average increase in **THROMBOCYTES** after exercise in group P1 by 13.64%, there was an average decrease in leukocytes after exercise in group P2 by 6.42%, there was a decrease in the average leukocytes after exercise in group P3 by 13.36%, This means that thrombocyte in groups P2 and P3 decreased compared to group P1.

Table 1. Mean of leukocytes and platelets in the exercise (P1), exercise and massage (P2), and exercise and massage with lime essential oil (P3)

Variable		P1 Group	P2 Group	P3 Group	Anova
					P
leukocytes	Pre-test	82600	83800	85800	0,000*
	Post-test	86700	78100	79100	
	%	4.37	7.29	8.47	
Thrombocyte	Pre-test	300200	316800	334200	0,000*
	Post-test	347600	297700	294800	
	%	13.64	6.42	13.36	

Note: * = significant (p<0,05), Sd: standard deviation

Recuperation, as soon as possible The following drill is absolutely necessary for any athlete who wants to improve their performance. It is possible to activate the muscle repair process by boosting the rate at which free radicals are removed from the body via improved microcirculation. Because it speeds up blood circulation, massage can make it easier to flush free radicals from the tissues of the body. Therefore, massage has the potential to indirectly lower levels of free radical generation.

A level of physical activity that is just moderately strenuous has the potential to generate an excessive number of free radicals, which may lead to oxidative stress. One strategy that can be implemented to reduce the negative consequences of oxidative stress is the consumption of antioxidants. When cells become inflamed due to environmental or internal factors like oxidative stress, the body responds by sending leukocytes to the scene to help in the healing process. Adrenal stimulation has an effect on the leukocyte profile. A surge in the number of leukocytes in the body may be caused by certain physiological stressors, such as engaging in strenuous physical exercise, experiencing intense emotions, or being subjected to extreme ambient temperatures [8].

Flavonoids, the most common form of phenolic chemical, are responsible for the antithrombotic action that can be observed in certain plants. This is accomplished by flavonoids, which stop the enzyme cyclooxygenase from breaking down arachidonic acid [9]. The anti-thrombocyte effects of vitamin C, which include the stabilization of the production of megakaryoblast and megakaryocyte cells as well as the prevention of tissue damage caused by free radicals, can have an effect on the growth of thrombocytes [10].

Regular exercise that is performed for an extended period of time and over a prolonged period of time will promote the synthesis of thrombocytes in the blood. This is because mild and moderate exercise induces an increase in thrombopoietin that is generated by the kidneys and liver. The increased demand for oxygen during periods of high physical activity prompts the body to produce more thrombopoietin. Because of this, thrombocyte synthesis in the bone marrow rises [11].

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Antioxidants are a potential method for reducing the harmful consequences of oxidative stress. The lime essential oil has antioxidant compounds called flavonoids. The oxidative stress caused by exercise has the potential to cause harm to cells and tissues, but antioxidants may be able to protect them. The immune system is influenced by the homeostasis changes induced by strenuous physical exercise [12].

Conclusion

This study finds that the application of lime essential oil used as topical massage oil is better to reduce inflammation and thrombosis. Free radicals are produced during intense exercise, but it is possible to keep them under check.

Acknowledgements

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Lactate Dehydrogenase (LDH) response on treated using combination lime essential oil and sports massage

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Abstract. *Continuous physical exercise has the potential to produce lactic acid. Lactic acid is produced under conditions that are hypoxic and the metabolic condition that occurs is anaerobic glycolysis. In anaerobic glycolysis conditions, Lactic Dehydrogenase (LDH), an enzyme, responds as a catalyst for the change from pyruvic acid to lactic acid. Sports Massage can improve blood circulation so that lactic acid can be eliminated, but this is not so effective. The lime essential oil contains antioxidants that can inhibit the production of lactic acid. The purpose of this study was to determine the response of LDH to the combination of the use of orange essential oil and sports massage. The experimental quasi-research method with pre and post-test group design. Participants were divided into 3 groups, exercise group (E) which was participants who did exercises and were not given massage; exercise with massage (EM) group, namely participants who do exercises and are given a massage with lotion; exercise with massage lime (EML) group, which is a participant who performs exercises and is given a massage with lime essential oil as the topical oil. The results showed that there were significant differences in LDH levels between each group. Using an orange essential oil as a lotion in massage regularly can affect the LDH response.*

Keywords: exercise, Lactate Dehydrogenase (LDH), lime essential, massage

Introduction

The production of free radicals beyond cellular defense antioxidants can occur in strenuous physical activity causing oxidative stress [1]. In oxidative stress states, an increase in free radicals causes an increase in lipid peroxidation and damages cell membranes [2]. The effect of physical activity on oxidative stress is divided into acute responses and chronic responses. Acutely, physical activity can increase the formation of free radicals, thereby increasing oxidative stress in the body. Whereas chronically, regular physical activity can increase endogenous antioxidant capacity, lowering oxidative stress in the body.

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Acute responses to aerobic and anaerobic physical activity can lead to the formation of free radicals [3]. Physical activity with heavy intensity really needs energy, causing the body's metabolism to increase. In this condition, the cells experience a decrease in oxygen supply so ATP in the body decreases. Therefore, to meet the needs of ATP, the body's metabolism will shift from aerobic metabolism to anaerobic metabolism (anaerobic glycolysis). This metabolism is catalyzed by the enzyme lactate dehydrogenase (LDH) [4].

Continuous physical exercise has the potential to produce lactic acid. Lactic acid is produced under hypoxic conditions and the metabolic impulse that occurs is anaerobic glycolysis. In conditions of anaerobic glycolysis, Lactate Dehydrogenase (LDH), which is an enzyme, responds as a catalyst for the change from pyruvic acid to lactic acid. Sports Massage can improve blood circulation. Previous research results showed that there was an increase in LDH levels in aerobic and anaerobic physical activity [5].

Research conducted by Rodas (2000), stated that there was an increase in LDH enzyme levels of 45% after anaerobic physical activity in the form of sprinting. In anaerobic physical activity, the source of energy comes from the phosphocterate system (alaktaside) and lactacid glycolysis (lactasid). The process of ATP formation from the lactacid glycolysis system has an impact on the formation of lactic acid and also increases the activity of the LDH enzyme [6].

Sports Massage can improve blood circulation so that lactic acid can be eliminated, but this is not so effective. Efforts to prevent an increase in LDH require a combination of the use of smear oils such as orange essential oil which contains antioxidants that can inhibit the production of lactic acid.

The purpose of this study was to determine the LDH response in the combination of the use of citrus essential oil and sports massage.

Methodology

Ethical approval

The Ethics Committee for the Implementation of Health Research at the University of North Sumatra has accepted this research protocol (reference number: 523/KEPK/USU/2022).

Protocol exercise

Experimental quasi-research method with pre and post-test group design. Participants were divided into 3 groups, exercise group (E) which was participants who did exercises and were not given massage; exercise with massage (EM) group, namely participants who do exercises and are given a massage with lotion; exercise with massage lime (EML) group, which is a participant who performs exercises and is given a massage with lime essential oil as the topical oil. Blood is taken before and after the exercise, then an LDH examination is carried out using the Colorimetry method.

Statistical analysis

The data were analyzed using either one-way analysis of variance (ANOVA) or a P-value less than 0.05 for statistical significance.

Results and discussion

According to the findings presented in table 1, there was a rise in the average LDH after exercise in group P1 of 9.38%, whereas there was a fall in the average LDH after exercise in group P2 of

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10.5% and there was a fall in the average LDH after exercise in group P3 of 15.14%. This indicates that LDH levels dropped after exercise in groups P2 and P3, in contrast to group P1.

Table 1. Mean of LDH

Variable		E Group	EM Group	EML Group
LDH (IU/L)	Pre-test	203	200	213
	Post-test	224	181	185
	%	9.38	10.5	15.14

Lactate Dehydrogenase (LDH) is an enzyme needed to catalyze the change from pyruvic acid to lactic acid under conditions of anaerobic glycolysis. LDH is an intracellular enzyme found in almost all living cells. LDH functions to catalyze the process of reducing pyruvate to lactate and produce NAD+. Its product, namely lactate is a by-product of this reaction. LDH affects the process of lactic acid formation, and LDH and lactic acid levels generally increase if there is cell damage [7].

Submaximal physical activity tends to potentially produce free radicals resulting in damage to the muscles. Based on the predominant energy, submaximal intensity is selected. Physical activity with submaximal intensity using anaerobic (lactic acid or LA) and aerobic (O2) energy sources with exercise time of 5 to 6 minutes demands the dominant aerobic speed and endurance in a person's sports success [8].

The results of this study are in line with the results of a study conducted by Rumley and Rafla (1983), which stated that physical activity can result in an increase in LDH levels in plasma. This is because physical exercise in general does not only purely use one of the aerobic or anaerobic metabolic systems, but uses a combination of the two systems.

The results of this research are also in line with the research of Harahap et al. (2021) showing a significant increase in LDH levels ($p=0.000$; $p<0.05$) in the treatment group, namely the group that was given heavy-intensity physical activity in the form of swimming until it almost drowned, compared to the control group, which is the group that did not swim [9]. In an exercise where hypoxia occurs in anaerobic physical activity, it has an impact on increasing the use of LDH in catalyzing lactate into pyruvate. Husin's research (2016) concluded that the increase in plasma LDH levels was not due to tissue damage. According to researchers, the increase in LDH is more due to an increase in lactate secretion as the end result of anaerobic metabolism, so LDH is needed to convert lactate into pyruvate so that it can be reused as an energy source.

Lime essential oil as a spreading oil on massage given after exercise can strengthen the effect of lactic acid elimination. So that the LDH response decreases indirectly through the antioxidant effects contained in citrus essential oil.

Conclusion

The use of orange essential oil as a lotion in massage regularly can affect the LDH response.

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Effects of red betel leaf (*Piper crocatum* Ruiz & Pav) extract on leucocyte as an inflammation response in rats

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Abstract. *Red betel leaf metabolite compounds contain flavonoids, alkaloids, tannins and polyphenols. The high flavonoid content shows red betel leaf has potential as an antioxidant and anti-inflammatory. The antioxidant activity of red betel leaf can neutralize free radicals in preventing oxidative stress and has an anti-inflammatory effect so that it can be used to strengthen the immune system. The purpose of this study was to determine the effect of red betel leaf on the number of inflammatory leukocytes. The research subjects used 20 experimental rats, male sex, 3-4 months old, body weight 200-220 grams. The research subjects were divided into 4 groups; group P1: rats were given red betel leaf extract 10 mg/rat for 14 days, then executed; group P2: rats were induced with lipopolysaccharides (LPS) Escheria coli, then the 4th day of execution; group P3: rats were given red betel leaf extract 10 mg/rat for 14 days. On the 10th day it was induced with lipopolysaccharides (LPS) Escheria coli, then on the 14th day it was executed; group P4: rats were induced with lipopolysaccharides (LPS) Eschericia coli, on the 4th day betel leaf extract was given for 10 days then the experimental animals were executed. The results showed that there were differences in the number of leukocytes in the 4 groups, the highest number of leukocytes was found in group P2 with an average of 9375 cells/mm3, and the lowest number of leukocytes in group P4 with an average of 6440 cells/mm3. The conclusion of the study is that red betel leaf extract has the potential to prevent the inflammatory response.*

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Keywords: antioxidant, infection, inflammation, leukocytes, red betel leaf

Introduction

Inflammation is a protective strategy evolved in higher organisms in response to detrimental insults such as microbial infection, tissue injury and other noxious conditions. It is an essential immune response by the host that enables the removal of harmful stimuli as well as the healing of damaged tissue. Acute inflammation has therefore been considered as a part of innate immunity, the first line of host defense against foreign invaders and danger molecules [1]. The most important feature of inflammation is the accumulation of white blood cells at the site of injury. Most of these cells are phagocytes, certain "cell-eating" leukocytes that ingest bacteria and other foreign particles and also clean up cellular debris caused by the injury [2].

Indonesia's biodiversity has great potential in the discovery of new compounds as antioxidants. Plants that contain antioxidants are scattered as in roots, stems, bark, twigs, leaves, fruit, flowers and seeds. The red betel plant (*Piper crocatum*), recently by the community has been widely used as an ornamental plant and as a medicinal herb, its utilization has not been maximized.

The metabolites of red betel leaf are reported to contain essential oils, flavonoids, alkaloids, tannins, saponins and polyphenols [3,4]. Red betel leaf bioactive compounds have the potential as anti-inflammatory [5], antioxidant [6,7], antimicrobial and cytotoxic [8,9]. The content of phenolic compounds (flavonoids) in red betel leaf which works as an antioxidant is higher than green betel.

This high flavonoid content indicates that red betel leaf has potential as an antioxidant and its methanol extract is reported to have anti proliferative effects. Antioxidants are needed to neutralize free radicals in preventing oxidative stress and have an anti-inflammatory effect so that they can be used to strengthen the immune system and protect the body from the risk of being infected with viruses. Reduced inflammatory response and increased immune system marked by a decrease in the number of white blood cells in the body [10].

Methodology

The research subjects used 20 experimental rats, male sex, 3-4 months old, body weight 200-220 grams. The research subjects were divided into 4 groups; group P1: rats were given red betel leaf extract 10 mg/rat for 14 days, then executed; group P2: rats were induced with lipopolysaccharides (LPS) *Eschericia coli*, then the 4th day of execution; group P3: rats were given red betel leaf extract 10 mg/rat for 14 days. On the 10th day it was induced with lipopolysaccharide (LPS) *Eschericia coli*, then on the 14th day it was executed; group P4: rats were induced with Lipopolysaccharide (LPS) *Eschericia coli*, on the 4th day betel leaf extract was given for 10 days then the experimental animals were executed.

Result

The results showed that there were differences in the number of leukocytes in the 4 groups, the highest number of leukocytes was found in group P2 with an average of 9375 cells/mm^3, and the lowest number of leukocytes in group P4 with an average of 6440 cells/mm^3.

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Table 1. Mean of leukocytes

Variable	P1 Group	P2 Group	P3 Group	P4 Group
Leukocytes	7771	9375	7362	6440

Discussion

Red betel leaf contains several chemicals including flavonoids, tannins, anthraquinones, alkaloids, terpenoids, saponins, glycosides, phlobatin and essential oils 0.8-1.8%. Red betel plant is believed to have potential as an antioxidant and anti-inflammatory because in the form of methanol extract it contains various active compounds including essential oils, alkaloids, saponins, tannins and flavonoids [11].

Flavonoids are natural phenolic compounds (often in the formation of polyphenols) which have antioxidant properties that function to neutralize free radicals. The results of research conducted by Fitriyani et al (2011) showed that the red betel leaf methanol extract given orally had anti-inflammatory activity in carrageenin-induced white rats [12]. It was reported that the red betel leaf ethanol extract could increase SOD (superoxide dismutase) levels and reduce MDA (malondialdehyde) levels in exposed mice [13].

The secondary metabolite compounds of polyphenols such as flavonoids, polyenes and compounds that contain lots of -OH groups are multifunctional and can act with free radicals as reducing agents, free radical scavengers, metal chelators and reducers of singlet oxygen formation [14] (Rao, 2011). The flavonoid compounds contained in the extract function to neutralize the occurrence of oxidation reactions involving free radicals, both exogenous and endogenous, preventing ROS generation or directly capturing ROS [15,16]. Flavonoids can directly capture superoxide and peroxynitrite and can also function as anti-inflammatory because flavonoids can inhibit the formation of proinflammatory cytokines such as TNF-, IL-6, IL-1β and interferon-γ [17].

The active compound in red betel leaf extract in the form of flavonoids can be used as an anti-inflammatory disease because flavonoid compounds, especially brazilin, can regulate transcription factor nuclear factor kappa B (NF-κB) to express TNF-α. This regulation causes inhibition of the secretion of the proinflammatory cytokine TNF-. Inhibition of COX and lipoxygenase pathways prevents the accumulation of leukocytes leading to decreased secretion of proinflammatory cytokines. Brazilin was effective in selectively suppressing the formation of the proximal IL-1R signaling complex but not TNFR-1. Brazilin is also able to inhibit the work of TACE which prevents the formation of the pro-inflammatory cytokine TNF-α through the formation of hydrogen bonds in proteins with negative binding energy affinities. Decreased expression of proinflammatory cytokines TNF-α and IL-6 causes a decrease in inflammation. Flavonoids in addition to functioning as anti-inflammatory can also function as primary and secondary antioxidants. As a primary antioxidant by providing hydrogen ions so that free radical ions become stable [18]. Meanwhile, as a secondary antioxidant by increasing the synthesis of the endogenous antioxidant enzyme superoxide dismutase (SOD). So that the stable ionic state causes a decrease in the state of oxidative stress in the tissue [19].

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Conclusion

The conclusion of the study is that red betel leaf extract has the potential to prevent the inflammatory response.

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Antioxidant potential of moringa leaf (*Moringa oleifera*) in reducing creatine kinase levels in male rats that received heavy physical exercise

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Abstract. *Oxidative stress caused by strenuous physical exercise can increase muscle damage due to inflammation and can be characterized by increased levels of creatine kinase in the blood. Oxidative stress and inflammation can be reduced by taking antioxidants. Moringa leaves are known to have antioxidant properties. The purpose of this study was to determine the effect of Moringa leaves on muscle damage by looking at creatine kinase activity in male rats that received heavy physical exercise. This research is experimental with posttest only control group design. The sample in this study was divided into 5 groups where each group consisted of 6 rats. The control group (0) was not given any treatment, the negative control group (I) was given heavy physical exercise, the intervention group (II), (III), and (IV) was given heavy physical exercise and a solution of Moringa leaf powder with different doses (100 mg/kg BW, 200mg/kg BW, and 400 mg/kg BW, respectively). Heavy physical exercise in mice was carried out by swimming for 50 minutes, 3 times a week for 30 days. Creatine kinase levels were measured in all groups at the end of the study. Moringa leaf powder solution in this study significantly ($p<0,05$) reduced creatine kinase levels in male rats who received strenuous physical exercise such as swimming. The results showed that Moringa leaves can repair muscle damage caused by strenuous physical exercise in mice.*

Keywords: moringa leaf, creatine kinase, heavy physical

Introduction

Physical activity has been shown to increase the production of various types of free radicals that damage cells [1]. Damage to muscle tissue, which is thought to be involved in the fatigue process and causes muscle pain characterized by elevated levels of creatine kinase (CK), was found to be more susceptible to oxidative damage and reduced antioxidant reserves as a result of physical activity [2,3,4]. In order to produce adenosine triphosphate (ATP) and creatine, the enzyme known as creatine kinase catalyzes energy reactions by removing phosphate from creatine and adenosine diphosphate. As a result, ATP becomes available for muscle contraction and other processes that require energy [5].

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The relationship between muscle activity and creatine kinase has been widely studied and gives a very varied response to physical exercise. Long-term intense exercise and eccentric muscle training usually increase creatine kinase [6,7]. Because it consistently results in the greatest perception of muscle pain, eccentric muscle training is frequently linked to the etiology of skeletal muscle damage [8,9]. Resistance exercise significantly increases creatine kinase levels, power resistance exercise in a higher total creatine kinase level than hypertrophy and strength types [10]. Submaximal physical exercise significantly increases creatine kinase levels in non-athlete students [11]. Different findings on creatine kinase levels which decreased not significantly in subjects who received eccentric exercise and concentric exercise [12].

Natural antioxidants [13,14] or synthetic antioxidants [15,16] have been used in a number of studies to counteract the effects of oxidative stress on physical activity, particularly strenuous activities. Since natural antioxidants have fewer side effects and are less expensive, many studies of medicinal plants rich in antioxidants have been conducted to prevent oxidative stress caused by physical activity. One of the natural ingredients that contain antioxidants is Moringa leaf (*Moringa Oleifera*), which is a miracle plant or the tree of life [17].

The active compounds found in Moringa leaves include flavonoids, alkaloids, tannins, glycosides, polyphenols and ascorbic acid [18]. Research that looks at the effect of Moringa leaves on oxidative stress due to exercise is also still limited. The purpose of this study was to determine the effect of Moringa leaves on muscle damage by looking at creatine kinase activity in male rats that received heavy physical exercise.

Methodology

Animal research ethics committees at FMIPA-Universitas Sumatera Utara, Indonesia, have granted "Ethical clearance" for this experimental study with a posttest-only control group design (approval number 0485/KEPH-FMIPA/2022). Thirty male white rats (R. norvegicus) aged 3 months and weighing 150-170 g made up the sample in this study. For a week, mice were allowed to eat and drink as much as they wanted in experimental animal cages to get used to the environment (acclimatization). While the temperature and humidity of the room remain in their natural ranges, the lighting in the room is controlled for precisely 12 hours—from 6:00 to 8:00 p.m. and from 6:00 to 6:00 a.m. The sample was divided into 5 groups, each group consisting of 6 rats, the control group (0) did not receive any treatment, only ate and drank ad libitum. The negative control group (I) received heavy physical exercise, the intervention group (II), (III), and (IV) was given heavy physical exercise and a solution of Moringa leaf powder with different doses (100 mg/kg BW, 200mg/kg BW, and 400 mg/kg BW, respectively). In this study, the strenuous physical activity was swimming as hard as possible until the rats almost drowned or showed signs of exhaustion, such as sinking almost all the way down except for the nose and loosing the ability to move the limbs. Swimming is done for 50 minutes, three times a week for thirty days. Moringa leaf used in this study was a solution of Moringa leaf powder which was given half an hour before the rats did swimming exercises. On the final day of treatment, after the rats had exhausted themselves by swimming, blood tests were done to determine their levels of creatine kinase. Blood was taken from the heart of the dead mice. Measurement of creatine kinase using the IFCC (International Federation of Clinical Chemistry) method.

The data obtained was analyzed using IBM SPSS statistics 25 for windows, the normality and homogeneity tests of the data were carried out using the Shapiro Wilk test and Levene test methods. Evaluation of changes between study variables was carried out by the ANOVA test

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followed by the LSD test. In this study, the decision on statistical tests was taken $P < 0.05$ which was considered significant.

Result

The goal of a study was to find out how giving male rats who did a lot of physical activity a solution of Moringa leaf powder affected their levels of creatine kinase.

Table 1. Differences in Creatin Kinase level in male rats

Parameter	Group					*P*
	P0	P1	P2	P3	P4	
CK (U/L)	185±28,43	433±153,96	291,80±75,78	266,20±80,73	217,80±26,62	0,001*
ANOVA test						

Description: P0 (Normal); P1 (Negative control); P2 (100 mg/Kg BW); P3 (200 mg/Kg BW); P4 (400 mg/Kg BW); mean ± SD; * indicates a significant difference between groups ($p<0.05$).

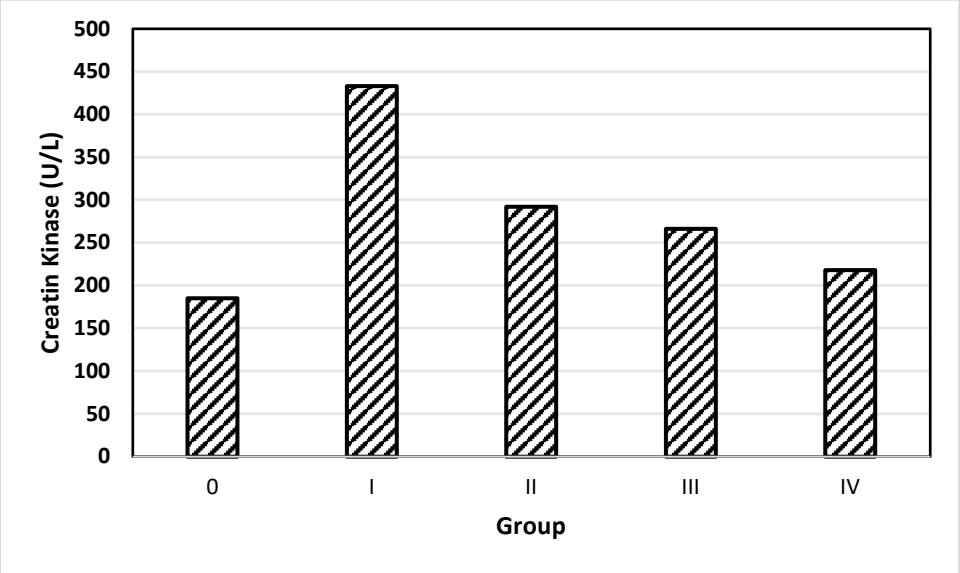


Figure 1. Effect of moringa leaf powder solution on creatin kinase levels in male rats that received strenuous physical exercise

In Table 1, it can be seen that the highest average creatine kinase level was found in the group that only received strenuous physical exercise and experienced a significant decrease in the group that received a solution of Moringa leaf powder. In a different test (Figure 1) of various doses of Moringa leaf powder solution, it was shown that a dose of 100 mg/Kg BW was effective in reducing creatin kinase levels in male rats that received heavy physical exercise.

Discussion

The results of this study showed that the rat group that received heavy physical exercise had the highest average creatine kinase levels. An enzyme called creatine kinase is found in the mitochondria and cytosol of tissues that need a lot of energy. Creatine kinase has two subunit types in the cytosol: M (the muscle type) and B (the brain type). The three tissue-specific

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isoenzymes CK-MB (cardiac muscle), CK-MM (skeletal muscle), and CK-BB (brain) are made possible by each subunit [19]. As a result, the presence of creatine kinase in the blood is typically regarded as an indirect indicator of muscle damage, particularly for the purpose of diagnosing conditions like myocardial infarction, muscular dystrophy, and brain disease. The increase in creatine kinase levels in this study is in line with the results of previous studies where swimming to exhaustion in mice can increase creatine kinase activity in the mouse serum [20]. Previous studies have also shown that resistance training and aerobic exercise increase plasma creatine kinase levels [21]. Creatine kinase concentrations vary depending on gender and race and also with the type of sport where eccentric exercise causes more muscle damage than concentric contractions of the same strength [22,23].

Giving moringa leaf powder solution in this study can reduce creatin kinase levels in rats that get heavy physical exercise. A dose of 100 mg/Kg BW has been effective in reducing creatine kinase levels. Moringa leaf (*Moringa Oleifera*), is one of the natural ingredients that contain antioxidants commonly known as the miracle plant or the tree of life. The active compounds found in Moringa leaves include flavonoids, alkaloids, tannins, glycosides, polyphenols and ascorbic acid. Polyphenols as natural antioxidants are the main plant compounds capable of reducing oxidative damage to tissues by indirect cell enhancement or by scavenging free radicals. The mature and tender leaves of the moringa plant, in particular, exhibit strong antioxidant activity against free radicals, preventing oxidative damage to important biomolecules and providing significant protection against oxidative damage. Previous studies have shown that the value of enzymatic and non-enzymatic antioxidants is better in the ripe Moringa leaf extract. Both mature and soft leaf extracts were shown to significantly reduce DPPH radicals by testing the DPPH free radical scavenging activity (2,2-Diphenyl-1-Picrylhydrazyl) [24]. The results of this study are similar to the results of previous studies which found that administration of ascorbic acid and moringa oleifera could reduce creatin kinase levels in male wistar rats exposed to lead [25].

Conclusion

Moringa leaves can repair muscle cell damage caused by oxidative stress from strenuous exercise, as evidenced by lower levels of creatine kinase in male rats who participate in physical swimming exercises.

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The effect of consumption of salak Sidempuan juice and heavy exercise on red blood cells and hemoglobin in rats

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Abstract. *Strenuous exercise can increase the production of free radicals, which can cause lipid peroxidation of cell membranes and damage the organization of cell membranes, including erythrocytes. This study aims to determine the effect of consumption of salak juice before strenuous exercise on erythrocytes and hemoglobin in white male rats. The research method used is a post-test and control group design. The research subjects were 30 rats with an average body weight of 150-180 grams divided into five groups. The CG group was a control group; the NSSJ group was given strenuous physical exercise without given salak sidempuan juice, the SSJ1 group was assigned heavy physical exercise (HPE) and 1 ml of salak sidempuan juice (SSJ), the SSJ2 group was given HPE, and 2 ml of SSJ, and the SSJ3 group given HPE and 3 ml of SSJ. All rats were given food and drink ad libitum. The research was carried out at USU's pharmaceutical laboratory. Rats were given a program of strenuous physical exercise 3 times a week for four weeks and salak juice every day for four weeks. Blood samples were taken two days after the end of the treatment. The results showed that strenuous physical exercise significantly reduced the number of red blood cells (p = 0.01) and hemoglobin (p = 0.03). Giving salak juice 1 mL, 2 mL, and 3 mL before strenuous exercise can significantly increase the number of red blood cells (p=0.01) and hemoglobin (0.03). The increase in red blood cells and hemoglobin is caused by salak's vitamin C content, which can increase iron absorption. In addition, salak's antioxidant capacity can also reduce oxidative stress, thereby reducing the increased regulation of hepcidin as a factor in the occurrence of sports anemia. The conclusion is that giving salak juice can increase the number of red blood cells and hemoglobin in experimental animals that do strenuous physical exercise.*

Keywords: Salak Sidempuan, juice, heavy exercise, red blood cells, hemoglobin

Introduction

Intensive exercise can significantly reduce hemoglobin (Hb), red blood cells, hematocrit (Ht), food intake and body weight[1]. Strenuous exercise can induce oxidative stress and upregulation of hepcidin which can cause exercise-induced anemia [2]. The type of exercise carried out also causes deformability of red blood cells, one of which is the type of combat sport[3]. Strenuous exercise causes an increase in adrenaline. Adrenaline causes spleen contraction and the release of hemolytic factors, which increase erythrocyte damage [4]. The adverse risks of strenuous exercise can be reduced by consuming foods that help maintain normal Hb levels.

Several studies have been conducted and giving Angelica Sinensis (AS) extract as much as 300 mg/kg BW/day during strenuous physical exercise can save you from sports anemia. Consumption of AS extract can increase red blood cell count, hemoglobin concentration and hematocrit level. Angelica Sinensis modulates iron metabolism by decreasing serum hepcidin-

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25 concentrations by 33% and raising serum iron levels by 34.3% [1].

Intermittent hypoxic exposure (IHE) exercise after intense exercise can reduce the decrease in Hb, red blood cells, and hematocrit, but this treatment does not consider food intake and body weight. IHE promotes increased erythropoiesis to increase hemoglobin concentration. In addition, IHE also increased renal EPO and prevented a training-induced decrease in Hb, RBC, and Hct [2]. Based on the explanation above, this study aims to determine the effect of consuming salak Sidempuan juice and heavy physical exercise on red blood cells and hemoglobin in white male rats.

Methodology

This research is experimental research with post-test and control group design. The white male rats (*Rattus novergicus*), 2-3 months old, with an average body weight of 150-180 grams, acclimatized for one week in animal cages. The provision of ad libitum food and drinks is carried out in a room with a 12-hour light/dark cycle, where the lights are on at 07.00 WIB. Humidity and room temperature are set at natural conditions (modified from research by Harahap et al., [5]). The ethical approval was obtained from the animal research ethics committee of the Faculty of Mathematics and Natural Sciences, the University of North Sumatra, with the number 0488/KEPH-FMIPA/2022.

There were 30 rats, randomized and divided into five groups. The group consisted of (1) the control group (CG), without giving salak Sidempuan juice and heavy physical exercise; (2) the group without giving salak sidempuan juice (NSSJ), given distilled water and heavy physical exercise; (3) the group giving salak Sidempuan juice 1 (SSJ1), given 1 ml/200grBB of salak Sidempuan juice and heavy physical exercise; (4) the group giving salak Sidempuan juice 2 (SSJ2), given 2 ml/200grBB of salak Sidempuan juice and heavy physical exercise; and (5) the group given salak Sidempuan juice 3 (SSJ3), given salak Sidempuan juice 3 ml/200grBB and heavy physical exercise.

Salak Sidempuan juice is made from the flesh of the salak fruit, blended without adding water. The obtained salak juice is filtered, and glucose syrup is added. Before the treatment, the rats swam until they almost drowned to determine their swimming endurance of the rats. In this treatment, 9 After two days, the rats were euthanized, blood was taken, and red blood cells and hemoglobin were examined. Examination of erythrocytes and hemoglobin using a hematology analyzer method.

Data were analyzed using the ANOVA test and continued with the Bonferroni post hoc test with the help of the SPSS 26 program.

Results

This study aims to determine the effect of giving salak juice in various doses during strenuous physical exercise on the number of red land cells and hemoglobin. The number of red blood cells and hemoglobin in rats after strenuous physical exercise for four weeks is shown in Table 1. Giving salak juice during strenuous physical exercise can affect the red blood cell count of rats, as shown in Figure 2. Giving salak juice during strenuous physical exercise can affect mouse hemoglobin shown in Figure 3.

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Table 1. Number of Red Blood Cells (RBC) and Hemoglobin of male rats after four weeks of treatment with heavy physical exercise and administration of salak juice with various doses

Variable	CG	NSSJ	SSJ1	SSJ2	SSJ3	p
Red Blood Cells (10^{12}/L)	9.79±1.49	5,53±0.88	7.00±2.45	7.48±0.54	8.88±0,33	0.00
hemoglobin (α/dL)	18.37±2.51	11.72 ±1.58	13,25±4,27	14.33±1.59	16.50±0.61	0.00

The results above indicate that the treatment of strenuous physical exercise for four weeks can reduce mice's red blood cell count compared to mice that are not given the treatment—giving salak juice before strenuous physical exercise can significantly increase the red blood cell count of rats among the treatment groups. The data above also shows that the heavy physical exercise treatment can reduce the hemoglobin count of rats compared to those not given strenuous physical exercise treatment. Giving salak juice before strenuous physical exercise with various doses can increase the hemoglobin count of rats significantly among the treatment groups.

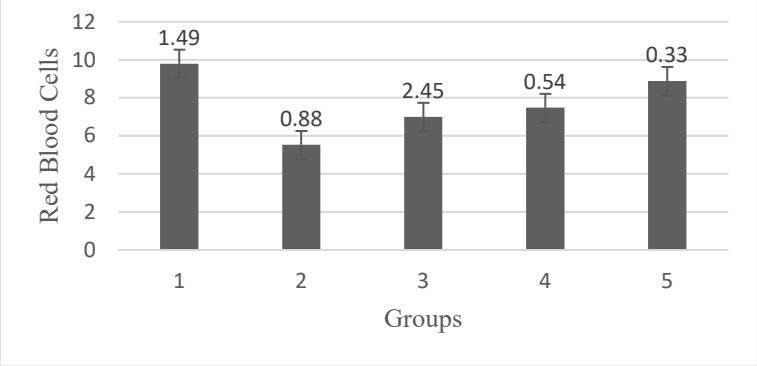


Figure 1. The relationship of consumption of salak Sidempuan juice on the number of red blood cells among the treatment groups
Notes: 1: CG, 2: NSSJ, 3: SSJ1, 4: SSJ2, 5: SSJ3

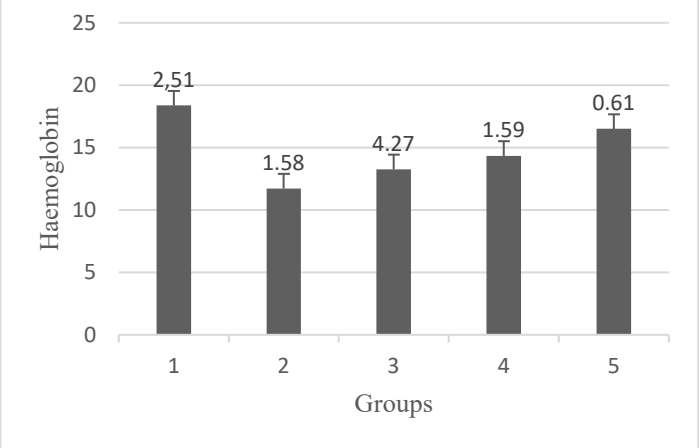


Figure 2. Relationship of consumption of salak Sidempuan juice to hemoglobin among treatment groups
Notes: 1: CG, 2: NSSJ, 3: SSJ1, 4: SSJ2, 5: SSJ3

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Based on the study presented in Table 1 and Figure 1, it was shown that administering Salak juice in various doses could increase the number of erythrocytes among the treatment groups. Giving salak juice with a quantity of 1 mL/200 gBW has been shown to significantly increase the number of erythrocytes in experimental animals.

Table 1 and Figure 2 show that administering salak juice with various doses can increase the amount of hemoglobin among the treatment groups. Giving salak juice with a quantity of 1 mL/200 gBW significantly increased the hemoglobin in experimental animals.

Discussion

Strenuous physical exercise can cause damage to body cells, including damage to erythrocytes and hemoglobin. Antioxidant foods can reduce oxidative stress's damaging impact [6]. Salak is one of the many fruits grown in Indonesia that can be used as natural food containing antioxidants. Salak contains several polyphenols, flavonoids, tannins, and monoterpenoids, which can be a perfect source of antioxidants [7,8,9].

Several previous studies have been conducted on the benefits of food sources of antioxidants in increasing the number of erythrocytes and hemoglobin. It is known that strenuous physical exercise can increase the occurrence of oxidative stress, and this is responsible for the process of destroying erythrocytes. Consumption of mangosteen rind supplement 550 mg half an hour before strenuous physical exercise can increase the number of erythrocytes and hemoglobin in male students. Supplements were consumed daily, and heavy physical exercise was carried out three times a week; the treatment was carried out for two weeks. The results showed that mangosteen rind supplementation could act as an antioxidant against erythrocytes and hemoglobin [6].

Consumption of red dragon fruit juice can prevent a decrease in the number of red blood cells and hemoglobin in trained people. The dosage is 2.8 g/kg BW and added 70 mL of water is consumed every day for 28 days, accompanied by physical activity with an intensity of 80-85% of the maximum pulse rate (DNM), three times a week for 30 minutes for 28 days. Giving fruit as a source of antioxidants before physical activity can increase the body's antioxidant capacity, thereby increasing the ability to reduce oxidative stress due to exercise [10].

Regular and planned exercise has beneficial effects in age-related changes, neuromuscular protection, increased blood flow and improved vascular integrity, angiogenesis, and cerebral blood flow and cognition [11,12,13]. However, on the other hand, strenuous physical exercise can increase hematological changes, such as a decrease in red blood cells, hemoglobin and hematocrit. These changes occur due to iron deficiency and negative iron balance caused by intense exercise [14,15].

Intense physical exercise increases levels of pro-inflammatory cytokines by sequestering iron produced in macrophages and decreasing iron absorption. The increase in pro-inflammatory cytokines can cause a decrease in the supply of iron to erythroid progenitor cells, thereby increasing the development of anemia [16]. A reduction of red blood cells can lead to a decrease in oxygen supply and energy production that regulates aerobic performance capacity [17], resulting in decreased physical performance, incorrect adaptation to training protocols, and possibly other physiological changes [18].

A decrease in blood cells and blood hemoglobin can be mediated by consuming varied foods rich in minerals and vitamins [19]. Vitamin C is an antioxidant and helps iron absorption [20]. Vitamin C is the only dietary component that promotes the absorption of non-heme iron in humans [21]. The usage of vitamin A, vitamin E, folic acid, cobalamin, and vitamin D3 increases the bioavailability and absorption of iron in the intestine. Vitamin C and vitamin E can affect

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their reducing power by blocking the synthesis of hydroxide-insoluble iron. In addition, these vitamins can synthesize complex solutes with iron by maintaining their solubility at alkaline pH in the duodenum [22]. Consumption of food sources of antioxidants and vitamin C when strenuous physical exercise can help improve the number of erythrocytes and hemoglobin.

Conclusion

Strenuous physical exercise can significantly reduce the number of red blood cells and hemoglobin in experimental animals. Giving salak juice doses of 1 mL, 2 mL, and 3 mL per 200 g/BW can significantly increase red blood cells and hemoglobin in experimental animals. Giving salak juice at a dose of 1 mL/200gBW has increased the number of red blood cells and hemoglobin in experimental animals.

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Ethnobotanical study of the Zingberaceae family in sibolangit subdistrict, north sumatra

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Abstract. *The purpose of the study was to determine the species of Zingiberaceaeae that were used by the community as ethnobotany. The results of this study are expected to add information on plant species of the Zingeberaceae family which are often used by the community as ethnic plants (ethnobotany). This research was conducted in 6 villages in Sibolangt sub-district, North Sumatra. Based on the results of the study, 17 types of plants were used in 6 villages in the Sibolangit sub-district, North Sumatra, namely Alpinia galanga (L.) Willd., Amomum campactum Soland. ex Maton, Curcuma aeruginosa Roxb., Curcuma heyneana Valeton & Zijp, Curcuma longa L., Curcuma xanthorrhiza Roxb., Curcuma zedoaria (Christm.) Roscoe, Etlingera elatior (Jack) R. M. Smith, Hedychium coronarium J. Koenig, Kaempferia galanga L., Kaempferia rotunda L., Zingiber cassumunar Roxb, Zingiber officinale Roscoe, Zingiber officinale var. amarum, , Zingiber officinale var. rubrum Zingiber ottensii Valeton, dan Zingiber zerumbet (L.) Roscoe ex Sm.. The part of the plant that is used on average is the rhizome the most, then there are fruits, flowers and stems. Some are used as medicinal ingredients, mixtures for cooking spices and ornamental plants. In practice, the Zingberaceae plants are found around houses, gardens and markets*

Keywords*:* Ethnobotanical study, Zingberaceae, sibolangit subdistrict, north sumatra

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Introduction

The Zingeberaceae family is known as gingers [1] or empon-emponan [2]. Zingiberaceae is a clump of plants, classified as basic plants from tropical forests which are mostly found growing in shady and humid places, some species are found in secondary forests and open forests. Having stems that are modified into rhizomes and having erect pseudo-stems originating from the leaf midrib, leaf buds will appear among the wet leaf litter of forest trees. Several species grow on riverbanks, open land and rocky cliffs and some are even epiphytic [3]. The Zingiberaceae family is also known for its characteristic rhizome which contains essential oils [4]. The volatile oil content in Zingiberaceae can be used as medicine and has a distinctive aroma [5]. In addition, the Indonesian people use Zingiberaceae as cooking spices, spices, ornamental plants, beverage ingredients, and hair tonic ingredients. 6. This plant is widespread from the tropics to the subtropics [6], [5]. Zingiberaceae can live from the lowlands to an altitude of more than 2000 meters above sea level, especially in areas with high rainfall [7].

The Zingiberaceae family is universally known as a group of ginger plants that have distinctive characteristics, including herbs, having rhizomes located at the bottom of the soil surface. Zingiberaceae rhizomes usually have aromatic compounds that characterize each species in their use for local residents [8]. Zingiberaceae is one of the plants that are commonly found in tropical forest areas, especially Indo-Malaya. It is not known exactly how many species there are Zingiberaceae. So far, areas rich in Zingiberaceae species are Indonesia, Malaysia, Brunei, Singapore, Thailand, the Philippines and Papua. As it is known that large areas such as Sumatra and Borneo are still very unknown and further investigated for the diversity of this type of ginger [5]. Most species of the Zingiberaceae family are found as terrestrial plants in the lowlands, but some are found in the mountains and live as epiphytes [9].

In the framework of theoretical interests, ethnobotany needs to be expanded with an interdisciplinary approach between botany and social sciences. Emphasis is carried out in an interdisciplinary manner will be able to solve problems that include socio-cultural aspects and people's perceptions and understanding of plants and their use in the life of a community group. Through the study of ethnobotany, it will reveal the way of thinking of a community group, concepts about plants, policies in the use of cultivation, and conservation of biodiversity, which are traditionally covered.

Local knowledge, including the use of plants as medicine, is mostly passed down orally or through written media in ancient manuscripts. Documentation of local community knowledge through ancient manuscripts has several obstacles including difficulty reading ancient manuscripts, many manuscripts have been lost and damaged [10,12]. The problem for lovers of traditional medicine is the lack of knowledge and information about various types of plants commonly used as ingredients in traditional medicine and how to use them [11, 13]. This study aims to find out what types of Zingiberaceae family are used by the community in 6 villages located in Sibolangit District and are expected to be useful as scienific data and references.

Methodology

This research was conducted in 6 villages located in Sibolangit sub-district, namely Sikeben, Bandar Baru, Sukamaju, Negeri gugung, puangaja and Rumah Kinangkung. The research was conducted from June to August 2022. The materials used in this study were plant species from the Zingiberaceae family, which have potential as medicine and are often used by the Karo Tribe. This type of research is a qualitative descriptive research through an emic approach and an

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ethical approach. The emic approach is intended to obtain data on people's knowledge about Zingiberaceae species according to their knowledge and discussion, while the ethical approach is used to analyze the knowledge data scientifically. The method in this study uses semi-structured interviews that are guided by a list of questions as a guide for asking questions to respondents, and is carried out in an open-ended manner. Interviews were conducted with the Karo Batak ethnic community who were considered to have broader knowledge such as shamans/ healers, traditional leaders, and community leaders about the types of plants used as ingredients for traditional medicine for the Toba Batak people. Determination of respondents using purposive sampling method which aims to collect information data about the use of Zingiberaceae which was chosen intentionally by the researcher.

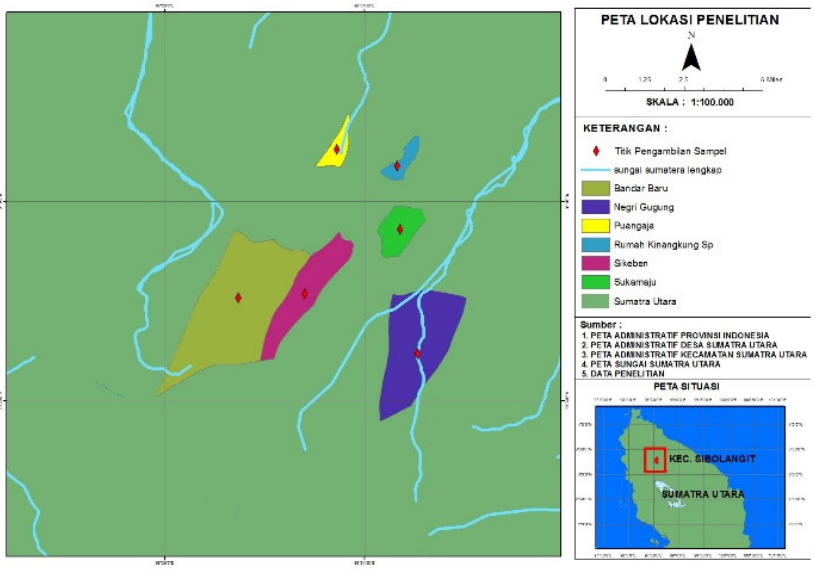


Figure 1. Research Locations in 6 Villages in Sibolangit District**,** North Sumatra

Result

In this study, plant species or local plants were inventoried through various villages in Sibolangit District. The results obtained as many as 17 species from the Zingiberaceae family used by the karo tribe in Sibolangit District, North Sumatra between lan *Alpinia galanga* (L.) Willd ., *Amomum campactum* Soland. ex Maton, *Curcuma aeruginosa* Roxb., *Curcuma heyneana* Valeton & Zijp, *Curcuma longa* L., *Curcuma xanthorrhiza* Roxb., *Curcuma zedoaria* (Christm.) Roscoe, Etlingera elatior (Jack) R. M. Smith, *Hedychium coronarium* J. Koeniggalan, Kaemp. , *Kaempferia rotunda* L., *Zingiber cassumunar* Roxb, *Zingiber officinale* Roscoe, *Zingiber officinale* var. amarum, , *Zingiber officinale* var. rubrum, *Zingiber ottensii* Valeton, and *Zingiber zerumbet* (L.) Roscoe ex Sm. (Table 1 and Figure 1).

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Table 1. List of plants found in Sibolangit District, North Sumatra

No	Scientific name	Local Name	General Name	Used Part	Utility
1.	***Alpinia galanga* (L.) Willd.**	Kelawas	Lengkuas	Rhizome	Cooking, Medicine
2.	***Amomum campactum Soland. ex Maton***	Kapulaga	Kapulaga	Fruit	Cooking, Medicine
3.	***Curcuma aeruginosa* Roxb.**	Kuning Pagit	Temu hitam	Rhizome	Medicine
4.	***Curcuma heyneana* Valeton & Zijp**	Kuning Gajah	Temu Giring	Rhizome	Medicine
5.	***Curcuma longa* L.**	Kuning gersing	Kunyit	Rhizome, Leaf	Medicine, Food coloring
6.	***Curcuma xanthorrhiza* Roxb.**	Temulawak	Temulawak	Rhizome	Medicine, Food coloring
7.	***Curcuma zedoaria* (Christm.) Roscoe**	Temu putih	Kuning terbabana	Rhizome	Medicine
8.	***Etlingera elatior* (Jack) R. M. Smith**	Asam Cekala	Kecombrang/ Honje	Stems, Flowers, Fruit	Cooking, Medicine
9.	***Hedychium coronarium* J. Koenig**	N'cole	Gandasuli	young stems	Decorative plants, Cooking
10.	***Kaempferia galanga* L.**	Keciwer	Kencur	Rhizome	Cooking, Medicine
11.	***Kaempferia rotunda* L.**	Kunyit putih	Temu Rapet	Rhizome	Medicine
12.	***Zingiber cassumunar* Roxb.**	Mburlei	Bangle	Rhizome	Medicine
13.	***Zingiber officinale* Roscoe**	Bahing alia	Jahe	Rhizome	Cooking, Medicine
14.	***Zingiber officinale* var. *amarum***	Bahing Perakis	Jahe emprit	Rhizome	Cooking, Medicine, drink
15.	***Zingiber officinale* var. *rubrum***	Jahe merah/ bahing merah/ bahing megara	Jahe merah	Rhizome	Medicine, drink
16.	***Zingiber ottensii* Valeton**	Laja	Bangle hantu	Rhizome	Medicine
17.	***Zingiber zerumbet* (L.) Roscoe ex Sm.**	Lempuyang	Lempuyang	Rhizome	Medicine

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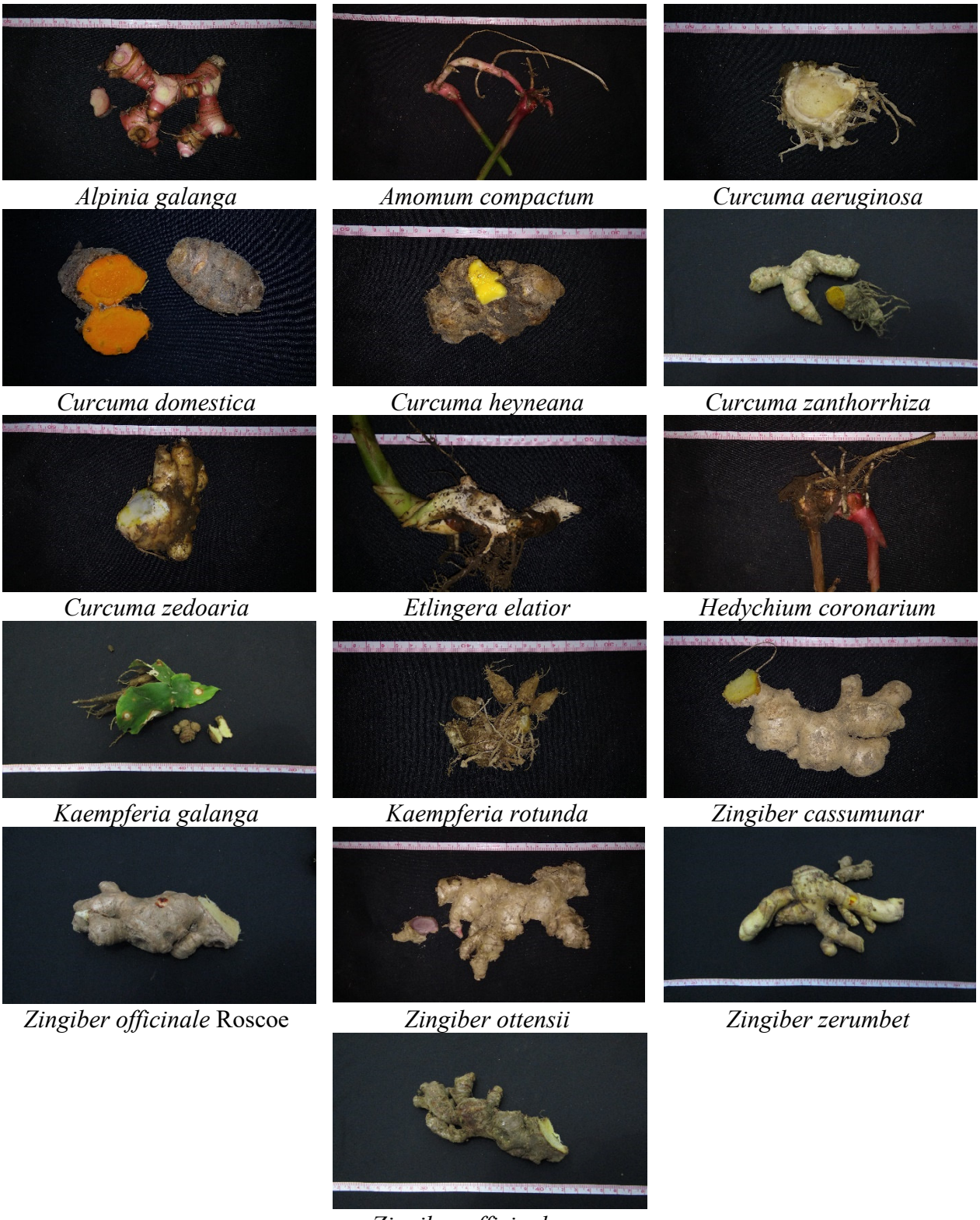


Figure 2. Some Zingiberaceae plants used by the community in 6 villages in the Sibolangit sub-district, North Sumatra

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Discussion

The majority of people in the villages of Sikeben, Bandar Baru, Sukamaju, Negeri gugung, puangaja and Rumah Kinangkung are ethnic karo. The Karo ethnic group as the majority of the people who inhabit the Sibolangit District, Karo Regency, have a close relationship with nature. Culture as a knowledge system is used by this ethnic group to understand and interpret their environment and experiences. Through this cultural knowledge, the Karo Ethnic created various local wisdoms in the utilization of plants. Moreover, the Karo region is strongly supported by the texture of the region which is famous for its fertility. So that various types of plants can thrive in this area.

Environmental domination actually plays an important role in playing the dominant role of the Karo Ethnic as users of local plants. This ethnicity produces various local knowledge systems in terms of processing various existing plants. In fact, the domination of the environment is very strong, encouraging this ethnic group to develop various rites related to nature and supernatural powers by utilizing various local plants which are considered to have magical meanings as well. The following are various forms of local wisdom possessed by the Karo Ethnic in utilizing plants in their area.

According to (Nasution 2009) plant species from the Zingiberaceae family contain bioactive compounds including essential oils, saponins, flavonoids and polyphenols which have medicinal properties. These plants are often used for medicinal purposes. Based on the results of the interview, the material was mixed with other materials. The part that is often used the most is the rhizome, then there are fruit, flowers and stems. Apart from being made into medicines, there are also zingiberaceae plants used as ornamental plants. Zingiberaceae plants that are used by the community on average have been cultivated. In addition, it can be obtained in the market / traded.

Based on the results of interviews with the community, this traditional medicine is used to maintain health, recover from minor ailments such as colds, chills, headaches, coughs and so on. The Karo people are very close to and know traditional medicines, almost all of the people use at least one of these types of drugs. This traditional medicine is also produced, its ingredients and products are traded in the market (Lavenia & Dewi, 2020).

Types of traditional medicines that contain Zingiberaceae species in their composition are widely produced and traded by the public, for example, such as; parem, spray, massage oil (karo oil), plain and ingredients for the filling

Parem

Parem is a medicinal herb in the form of a white or light brown solid. The production of parem in the Karo tribe is based on the philosophy of kesaya silima-lima, which means five types of basic plants in making potions, namely bahing (Zingiber officinale Roscoe), pepper (Piper nigrum L.), keciwer (Kaemparia galanga L.), pia (Allium cepa L.), .) and lasuna (Alium sativum L.) (Silalahi, 2019).

In addition, the parem herb also contains laja (Zingiber ottensii Valeton), temulawak (Curcuma xanthorrhiza Roxb.), elephant yellow (Curcuma heyneana Valeton) and other ingredients. The herb is used at night after bathing to warm the body by applying it to all parts of the body. Parem is divided into 3 types, namely parem children, parem adults (parem melas), and parem rheumatism.

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Sembur

The basic ingredients for the spray are not much different from parem and still adhere to the kesaya silima-lima philosophy. Spray is a medicinal herb in the original form or chopped from ingredients which will be chewed and sprayed onto the body part that is experiencing pain, but some have been ground in powder form. The ingredients in the spray consist of gonseng rice (Oryza sativa L.), bahing (Zingiber officinale Roscoe), pepper (Piper nigrum L.), fennel (Foeniculum vulgare Miller) and other ingredients. This drug is widely used for colds, stomachaches and headaches

Minyak urut

Massage oil or better known as Karo Oil is a liquid ingredient. This herb is made from dozens of types of plant extracts and medicinal plants with the addition of coconut oil (Cocos nucifera L.). The ingredients from the Zingiberaceae family are mburlei (Zingiber cassumunar Roxb.), yellow gersing (Curcuma longa L.), keciwer (Kaempferia galanga L.) and other ingredients. The production of massage oil has been carried out by many people in Sibolangit, but it is still on a local scale. It is divided into two types, namely hot and cold massage oil. These two oils have different compositions. This drug only serves as an external drug.

Tawar

The basic ingredients for the spray are not much different from parem and still adhere to the kesaya silima-lima philosophy. Spray is a medicinal herb in the original form or chopped from ingredients which will be chewed and sprayed onto the body part that is experiencing pain, but some have been ground in powder form. The ingredients in the spray consist of gonseng rice (Oryza sativa L.), bahing (Zingiber officinale Roscoe), pepper (Piper nigrum L.), fennel (Foeniculum vulgare Miller) and other ingredients. This drug is widely used for colds, stomachaches and headaches

Tawar has a function as disease prevention and treatment. These two types of bargaining have differences in composition. Bargaining that is useful in preventing disease, for example, bargaining (restoration of stamina due to fatigue) and bargaining (disease brought from the womb). According to Silalahi (2021), there are 17 types of bargaining that have a function as a treatment and have specific functions. This color is used in the treatment of cholesterol, kidney, impotence, fertility, ulcers, shortness of breath and others. The materials used include; bahing (Zingiber officinale Roscoe), lasuna (Alium sativum L.), pepper (Piper nigrum L.), fennel (Foeniculum vulgare Miller) and many other plants.

Oukup

The herbs in the oukup are dominated by the Zingiberaceae family, because they are in great demand, easy to obtain and the heat effect they cause. Adequate ingredients from the Zingiberaceae family include bahing (Zingiber officinale Roscoe), keciwer (Kaempferia galanga L.), yellow gersing (Curcuma longa L.), temulawak (Curcuma xanthorrhiza Roxb.) and kelawes (Alpinia galanga (L.) Willd). In addition to Zingiberaceae, the ingredients used also come from the Asteraceae, Rutaceae, Arecaceae, Malvaceae, Poaceae, Acanthaceae, Rubiaceae, Lauraceae and Myrtaceae families. In Sibolangit, it is mostly done after giving birth, but it is also used for cough medicine, colds, skin pain, fatigue and rarely for serious diseases such as diabetes, ulcers

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and gout. Currently, the ingredients for oukup are very easy to obtain and have been traded in traditional markets.

Conclusion

Based on the results of the study, it was found that the community in 6 villages of Sibolangit District North Sumatra utilized as many as 17 types of plants that were utilized by the Karo tribe, namely *Alpinia galanga* (L.) Willd., *Amomum campactum Soland. ex Maton, Curcuma aeruginosa* Roxb., *Curcuma heyneana* Valeton & Zijp, *Curcuma longa* L., *Curcuma xanthorrhiza* Roxb., *Curcuma zedoaria* (Christm.) Roscoe, *Etlingera elatior* (Jack) R. M. Smith, *Hedychium coronarium* J. Koenig, *Kaempferia galanga* L., *Kaempferia rotunda* L., *Zingiber cassumunar* Roxb, *Zingiber officinale* Roscoe, *Zingiber officinale* var. *amarum, Zingiber officinale* var. *rubrum Zingiber ottensii* Valeton, dan *Zingiber zerumbet* (L.) Roscoe ex Sm. Most of it is used as a mixture of medicinal ingredients, then cooking spices and ornamental plants.

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Effect of consumption of branched chain amino acid on fatigue and muscle damage on physical activity – metanalysis

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Abstract. *Research with randomized trials related to Branched Chain Amino Acid (BCAA) supplementation has been widely carried out in sports. From the results of research that has been done, inconsistent results have been found regarding the benefits of using BCAAs. Inconsistent research results may be due to variations in exercise protocols and BCAA supplementation protocols. This study focuses on BCAA supplementation against fatigue (lactate ammonia) and muscle damage. This study aims to analyze the consistency of the effect of BCAA supplementation on fatigue and muscle damage during exercise. This study uses a meta-analysis method by reviewing several articles in international journal. Te data obtained were then compiled and extracted. Research searches were carried out through Google Scholar and Research Gate conducted from the beginning to 2022. The results of this study did not prove a significant effect on fatigue but BCAA consumption had a significant impact on muscle damage. Therefore, it can be concluded that BCAA have a good role in training performance.*

Keywords: BCAA, Fatigue, Muscle Damage

Introduction

In order to increase the benefits of exercise both for fitness and to improve physical fitness, the general public and athletes will supplement their nutritional intake with supplement, especially protein. Numerous studies have also revealed that protein provides several exclusive benefits of protein consumption, such as supporting immune strength, improving aerobic performance, increasing anaerobic capacity, speed and power in strength based sports, optimizing post-workout recovery, building muscle mass, improving body composition, sports performance and the role of glutathione (GsH), and a better recovery process [1].

Proteins consists of amino acid chains. These amino acid chains are linked together in peptide bonds. Amino acids can generally be divided into two types, namely essential and non-essential amino acids. Essential amino acids cannot be produced by the body, so many studies have demonstrated the benefits of branched chain amino acids [2]. In line with this, branched chain amino acids have also been widely used for sports performance either fitness or achievement.

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Branched Chain Amino Acids commonly known as BCAAs (Branched Chain Amino Acids) have an important role in physical activity and maintenance of skeletal muscle growth. BCAA consists of 3 kinds of essential amino acids, namely leucine, isoleucine, and valine which play an important role in protein synthesis and muscle energy system during exercise. BCAA supplementation can increase substances of muscle fatigue, energy metabolism and muscle damage. Substances of muscle fatigue are lactate, ammonia and 5-HT; energy metabolism are glucose and free fatty acids; and muscle damage are Lactate Dehydrogenase (LDH) and Creatine Kinase (CK) [3].

Muscle fatigue is a functional sign and muscle damage is a structural sign that can be observed after prolonged exercise such as running a marathon or after strenuous exercise, especially involving eccentric contractions. Fatigue due the prolonged exercise, hypoxic conditions and generation of free oxygen radicals are important causes, resulting in increased lysosomal activity, High –intensity eccentric exercise places mechanical stress n the fibers. Although these different mechanisms can be seen experimentally, they produce similar muscle disorders.

Research with randomized trials relate to BCAAs has been carried out a lot. The use of BCAAs was investigated for the effect on exercise and found inconsistent results. This inconsistent results caused by variations in exercise. In addition, it can be caused by different BCAA supplementation protocols in each study, such as the amount, time of consumption and so on.

Branched Chain Amino Acids (BCAA)

Branched chain amino acids (BCAAs) play an important role especially during activity and in the maintenance and growth of skeletal muscles. BCAAs, from approximately 40% of the free essential amino acids in blood plasma, and are used as a source of energy furring activities when needed, and play an important role in the process of gluconeogenic (a mechanism for reusing glucose as energy).

BCAA consists of 3 kinds of essential amino acids, namely leucine, isoleucine and valine, which are the main amino acids that play a role in protein synthesis and the muscle energy system during exercise. Leucine has important function as amino acids because it directly stimulates the body to synthesize protein [4].

The three branched chain amino acids (BCAAs), leucine, isoleucine and valine, are essential amino acids that play an important role in protein structure, metabolism, and regulation. In the mid-1970s, it was demonstrated that BCAAs, particularly leucine, are potent regulators of protein turnover. In the 1980s, it was also shown that competing with Large Neutral Amino Acids (LNAAs), which by increasing levels of BCAAs in the blood will limit the formation of false neurotransmitters in the brain [5]. BCAAs reach peak blood levels 10 minutes after administration[6].

Skeletal muscle is the main site of BCAA catabolism. This suggests that there are important differences between BCAAs other amino acids that ae normally metabolized in the day and in the small intestine. Of course, following intake of protein-rich foods, there is an unbalanced increase in the number of amino acids in the bloodstream. This is a signal for BCAAs to act in the regulation of various cellular processes.

The increase in circulating BCAA levels in the blood following a protein-containing meal is sensed by several different body tissues. The brain and skeletal muscle are among the tissues that are affected by BCAA levels [5,6].

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Amino acids that have an important role in the mechanism of muscle contraction are Branched Chain Amino Acids (BCAAs). Branched chain amino acids, especially leucine, regulate protein synthesis and protein degradation. BCAA supplementation helps prevent protein catabolism caused by decreased glycogen levels in the muscles. The regulatory process of protein synthesis is very complex.

In this case the stimulation of protein synthesis is very clear that one of the intra cellular targets of insulin is a protein kinase known as mTOR. Leucine also activates mTOR to stimulated protein synthesis in addition to maintaining body mass during weight loss and the aging process and accelerating wound healing.

All BCAA catabolic processes occur in the mitochondria. The reaction of changing branched chain amino acids into branched chain α-keto acids is catalyzed by Branched Chain Amino Transfer (BCAT). This reaction is reversible. The second reaction is catalyzed by Branched Chain α-keto Acids Dehydrogenase (BCKDH), which is an irreversible decarboxylation oxidation reaction. BCKDH has two forms, namely active and inactive. The activation of the BCKDH complex is caused by the activation of the BCKDH kinase. The activation process by BCKDH phosphate is a dephosphorylation reaction which releases phosphate bonds in the inactive BCKDH complex. The inhibition reaction by the inactive BCKDH complex. The inhibition reaction by the BCKDH kinase enzyme will break down ATP into ADP and phosphate. This phosphate will bind to the active BCKDH complex and will cause it to become inactive [7].

Fatigue

Fatigue is a condition accompanied by a decrease in efficiency and endurance at work. Fatigue is a body's protective mechanism so that the body avoids further damage, so that recovery occurs. There are two types of fatigue, namely muscle fatigue and general fatigue. Muscle fatigue is a tremor the muscles or a feeling of pain in the muscles. General fatigue is characterized by a reduced willingness to work, which is caused by nerves or psyche.

Muscle fatigue is a condition where the muscles are no longer able to contract du to strong and prolonged muscle contractions. If the muscle is stimulated continuously, it is in accordance with te mechanism of muscle contraction which requires ATP fo actin-myosin attachment and pumps back ions such as potassium, sodium, and calcium. At the end of the muscle contraction process, the actin filaments will be closed again by the troponin-tropomyosin complex, K potassium) will return to the intracellular, Na (sodium) will be pumped to the extracellular, and Ca (calcium) ions will be pumped back to the sarcoplasmic reticulum.

Fatigue shows different conditions for each individual, but all leads to a loss off efficiency and a decrease in work capacity and endurance. The occurrence of fatigue can be caused by several conditions such as monotonous conditions, loads, and length of work both physical, mental, environmental conditions, psychological conditions, as well as illness, feeling sick and nutritional conditions.

Fatigue is a stage of physical functional condition between deep sleep and dangerous conditions, which are successively deep sleep (deep sleep), somewhat sleepy (drowsy) fatigue (body feels heavy), relaxed (rest), refreshed/ alert, very alert/ aroused, and in danger. The functional stage was intended as a means of safety for the body so that health problems do not occur.

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Feelings of tiredness are actually protective, just like feelings of thirst and hunger. The presence of feeling tired means telling humans to avoid further tension and provide an opportunity to recover and be refreshed.

During activity, blood glucose levels decrease which stimulates gluconeogenesis. This increases the catabolism of branched chain amino acids (BCAAs) which causes BCAA levels in the blood to fall [5], [6]. BCAAs compete with tryptophan in terms of transporters to pass through the blood-barrier in the brain. BCAAs compete with tryptophan in terms of transporters across the blood-barrier in the brain. When BCAA levels in the blood fall, the tryptophan that enters the brain increases. Serotonin (5-HT) is a neurotransmitter in the brain that causes feelings of calm, relaxation, drowsiness, and lazy activity through inhibition of the excitation system of the brain, especially through the reticular formation. This situation is exacerbated by an increase in fee fatty acid levels during activity which increases the use of albumin by free fatty acids (FFA) so that free tryptophan in the plasma increases.

Muscle Damage

Muscle damage can be affected by the dose of exercise and the intensity of the exercise given. If it happens to someone who is not a professional (athlete), damage can be caused due to muscle activity that exceeds ability when carrying out wrong activities and movements.

Delayed Onset Muscle Soreness (DOMS) is a type of injury that causes pain and discomfort after doing unusual (high-intensity) exercises. According to Zondi in (Prihantoro and Ambardini, 2018) Delayed Onset Muscle Soreness is pain in the muscles and a feeling of "me" that continues to develop for 24-72 hours after sports activity. DOMS is recognized by the presence of pain that appears 12-24 hours after exercise and will reach its peak within 24-48 hours.

Biologically, DOMS is damage to muscle contractile structures (actin and myosin) that disrupts muscle performance. The occurrence of this damage will be responded by the body by doing inflammation as an initial effort to start healing. Inflammatory events are characterized as an initial attempt to initiate healing. Incidence of inflammation is characterized by the presence of pain the pationet, the pain will reach its peak at 48 hours after the injury.

DOMS is caused by exercise-induced muscle damage. The inflammatory response occurs after morphological damage caused by eccentric muscle contraction. Chemokines (regret proteins) are released in damaged muscle, making inflammatory cells such as neutrophils and macrophages more active. Because acute inflammation in damaged cells, it causes levels of bradykinin, leukotrienes and prostaglandins to increase simultaneously. When inflammatory cells are activated in damaged muscle, muscle swelling occurs resulting in increased intramuscular pressure and sensitivity of type III and IV afferent fibers. When these stimuli reach the medulla and cerebral cortex via the spinal cord, muscle pain will be felt. Nerve Growth Factor (NGF) or nerve growth factor is known to increase pain response, and NGF secreted by inflammatory response can stimulated nociceptors (nerve alarm signal) [3].

Methodology

This study uses a meta-analysis method by reviewing several article in national and international journals. Populations in this study were all national and international sports research journal that were founs using Google Schoolar electronic database search. The keywords used are BCAAs or branched chain amino acids combined with the words fatigue, muscle damage, physical activity and exercise, int the literature search engine. The hournal samples included in this study were

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selected from articles using experimental or quasi-experimental research methods with BCAA consumption n fatigue and muscle damage after physics activity. Several inclusion criteria were included in this study.

Table 1. Selected journal

No	Year	Title	Author	Subject	Intervention	Dossage (g)
1	1993	Branched chain amino acid supplementation augments plasma ammonia responses during exercise in humans [7]	D. A. Maclean anf T. E. Graham	7 men	60 min on bike	77mg/kg
2	2021	Metabolic impacts of branched chain amino acid supplementation during endurance exercise: a crossover study	Jeese T. Peach, Dakota Funk, Lizzi Frotingham, Hunter Fausset, Isaac Rowland, Brian Bothner, Mery P. Miles	10 edurance runner	60 min on bike at 65% of VO2maks	8g (2.5g leucine, 1.25g isoleucine, 1.25g valine)
3		The effect of acute branched chain amino acid supplementation on recovery from a single bout of hyperthrophy exercise in resistance-trained atheletes [8]	Mark Waldron, Kieran Whelan, Owen Jeffries, Dean Burt, Louis Howe, Stephen David Patterson	16 (BCAA= 8; palcebo= 8)	6 set of full squats at 70% 1RM to induc muscle damage	0.087g/kg dengan rasio 2:1:1leucine, isoleucine, and valine
4	2015	Changes in serum free amino acids ad muscle fatigue experienced duting a half-ironman triathlon	Francisco Areces, Juan jose Salinero, Cristina Gonzalez Millan, Javier Abian-Vicen	26 triathlon	before and after the race, a countermove ment jump and a maximal isometric force	
5	2019	Branched chain amino acids don't improve muscle recovery from resistance exercise in untrained young adults	Jeferson Lucas Jacinto, Juliano Moro Gabardo, Mirela C. Roveratti, CosmeFranklin Buzzachera		Resistance exercise in untrained young adults	8g

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6	2022	Research Article - The application of DOMS mechanism and prevention in physical education and training	Cong Zeng, Ge Luo, Shijun Xu, Yi Li	125 students	interview, on site observation, and mathematical statistic	
7	2022	Protective effect of amino acids on the muscle injury of aerobics athletes after endurance exercise baed on CT images	Xianghai He, Yingjun Zhang	32 aerobic athletes		
8	2016	Effects of whole - body vibration after eccentric exercise on muscle soreness and muscle strength recovery	Rafael Timon, Javier Tehero, Javier Brazo-Sayavera, Carmen Crespo, Guilemo Olcina	20 untrained participants	Eccentric quadriceps training of 4 sets of 5 repetition at 120% 1RM	
9	2020	Effect of branched chain amino acid supplement on knee peak torque and indicators of muscle damage following isokinetic exercise-induced delayed onset muscle soreness	In--Soo Lim	12 men	Isokinetic intervention	AMINO VITAL 400 (A. Japan) contains 3g, 4.0g dan 1mg of BCAA, protein (leucine 1.60g, isoleucine 0.43g, valine 0.44g, dan another amino acids 1.51g), dan vitamin B
10	2010	Release of muscle α-actin into serum after intensive exercise	Antonio Martinez-Amat, Fidel Hita-Contreras, Jose Prados	13rugby players dan 10 handball players		

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11	2015	Branched chain chain amino acids and arginne improve performance in two consecutive days of simulates handball games in male and female athletes: a randomized trial	Chen-Kang Chang, Kun-Ming Chang Chien, Jung-Hsien Chang, mei-Hsuan Huang, Ya-Chuan Liang, Tsung-Han Liu	17 laki-laki dan 7 perempuan pemain handball	60menit simulasi handball games	0.17g/kg BCAA dan 0.04g/kg arginine
12	2018	The effect of branched chain aminoacids, citruline, and arginine on high intensity interval performance in young swimmers	Chun-Fang Hsueh, Huey-June Wu, Ts-Shiou Tsai, Ching-Lin Wu dan Chen-kang Chang	8 laki-laki (usia 15.6+-1.3 tahun), 8 perempuan (usia 15.6+-0.9 tahun)	8x50m high intensity interval swim	0.085g/kg body weight BCAA, 0.05g/kg body weight arginine
13	2016	Branched chain amino acids , arginine, citrulline alleviate central fatigue after 3 simulated matches Intaekwondo athletes: a randomized controlled trial	I-Fan Chen, Huey-June Wu, Chung-Yu Chen, Kuei-Ming Chou, dan Chen-Kang Chang	12 male taekwondo athletes	Three 2-min rounds of high intermittent exercise	0.17g/kg BCAA, 0.04g/kg arginine, dan 0.05 citrulline
14	2015	Effects of supplementation with branched chain amino acids and ornithine aspartate on plasma ammonia and central fatigue during exercise in healthy men	Tomasz Mikulski, Jan Dabrowski, Wojciech Hilgier, Andrzej Siemba, Krzysztof Krzeminski	11 endurance-trained men	2 sesi submaksimal cycloergometer exercise for 90 minutes at 60% maximal oxygen uptake (dipisahkan 1 minggu/sesi)	16g BCAA + 12g ornithine aspartate
15	1995	Ingestion of branched chain aminoacids and tryptophan duringsustained exercise in man: failure to affect performance	G. van Hall, J.S.H. Raaymakers, W.H.M. Saris and A.J.M.Wagenmakers	10 endurance trained male athletes	Cycle exercise at 70-75% maximal power output	low and high dose BCAA

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16	2006	Effect of dietary leucine supplementation on exercise performance	Melissa J. Crowe, Jarrad N. Weatherson, Bruce F. Bowden	13 orang (10 perempuan, 3 laki-laki)	10's upper body power and work and a row to exhaustion at 70-75% maximal aerobic power	Leucine
17	2012	A protein-leucine supplement increases branched chain aminoacid and nitrogen turnover but nor performance	Andre R. Nelson, Stuart M. Philips, Trent Stellingwerff, Serge Rezzi, Stephen J. Bruce, Isabelle Breton, Anita Thorimbert, Philippe A. Guy, Jim Clarke, Suzanne Broadbent, dan David Stephen Rowlands	12 male cyclist		LEUPRO 7.5/20/89/22 g>h -1
18	2011	Leucine enriched essensial amino acid supplementation during moderate steady state exercise enhances postexercise muscle protein synthesis	Stefan M. Pasiakos, Holly L. McClung, james P. McClung, Lee M. margolis, nancy E Andersen, Gregory J Cloutier, Matthew A Pikosky, jennifer C. Rood, Roger A Fielding, dan Andrew J Young	8 orang dewasa	2 separate bouts of cycle ergometry (60 menit, 60%VO2maks peak)	Leucine

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19	2019	Changes in body composition, energy metabolism, and appetite-regulating hormones in Korean Professional Female Ballet Dancers Before and After Ballet Performance	Soo Youn Kim, Jung Ho Cho, Ji Hyun Lee, Jae Hyun Jung	43 professional female ballet dancers		
20	2022	Effects of supplementatation with ginseng and branched chain amino acids improved central fatigue and enhanced attention during exercise: A randomized, double blind, placebo controlled	Yung-Kai Lin, Bo Han Wu, Yung-Hsiang Link, Shu-Ting Chan, Chi-Fu Chiang	16 subject	Exercise program in 3 weeks	
21	2020	Effects of Oral Branched Chain Amino Acids (BCAAs) Intake on Muscular and Central fatigue during an incremental exercise	Mohammad Fayiz, Zainalabidden Al-Abdulla, Laila M. Matalqah	16 runners	14 days incremental exercise session on a treadmill	20g
22	2015	Ten weeks of branched-chain amino acid supplementation improves select performance and immunologigal variables in trained cyclist	Wesley Kephart, C Books Mobley, Richard M. Thompson, Carlton D. Fox.	9 orang		12g/d (6g/d L-Leucine, 2g/d L-Isoleucine and 4g/ L-Valine
23	2012	Branched chain aminoacid supplementation duringa 100-km Ultra marathon-A randomized controlled trial	Beat Knechtle, Claudia Mrazek, Andrea Wirth, Patrizi Knechtle, Christoph Alexander Rust, Oliver Senn, Thomas Rosemann, Reinhardd Imoberdorf, dan Peter Ballmer	28 athletes	100km ultra marathon	50g consists of 20g BCAA

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24	2001	Plasma lactate, GH and Gh-binding protein levels in exercise following BCAA supplementation in athletes	E. F. De. Palo, R. Gatti, E. Cappellin, C. Schiraldi, C. B. De Palo, dan P. Spinella			0.2g/kg of body weight
25	2006	Infuence of Branched chain amino acid supplementation on urinary protein metabolite concentrations after swimming	Fu-Chun Tang	19 Male universit y students	600m crawl stroke	12gg of BCAAs/day
26	2008	Branched chain aminoacid supplementation and indicators of muscle damage after endurance exercise	Beau Kjerulf Greer, John L. Woodard, Jim P. White, Eric M. Arguello, dan Emily M. Haymes	9 untrained men	three 90-min cycling bout at 55% VO2peak	200kcal of energy via the CHO or BCAA
27	1993	Effect of protein supplementation during prolonged exercise at moderate altitude on performance and plasma amino acid pattern	A. X Bigard, P. Satabin, P. Laire, F. Canon, D. Taillandier, dan C.Y Guezenne	29 healthy males	7 stage of ski mounteineeri ng	

Result

This study focused on BCAA supplementation effect on fatigue and muscle damage. Fatigue is characterized by accumulation on lactate and ammonia. Meanwhile, muscle damage is characterized by lactate dehydrogenase and creatine kinase. Results from the searching, 27 studies were found related to BCAA supplementation on muscle fatigue and damage as a source of analysis with randomized trials. The results of the analysis based on the article found that BCAA supplementation can significantly suppress lactate production. This is due to an increases in catabolism in BCAAs. In addition, BCAAs trigger cell reactions to maintain their energy sources. The results of BCAAs on muscle damage were found to be significant on long term consumption. Overall, BCAAs have benefits and are effective in their use as exercise supplementation

Conclusion

Branched chain amino acid (BCAA) are beneficial against muscle breakdown and fatigue.

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Growth performance and proximate composition of meat and shell from snails (*Achatina fulica*) fed with household organic waste

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Abstract. *Snails are known as pests that eat various types of plants, and they can consume and reducing the household organic waste. This study aims to determine the growth of snails, proximate composition of snail meat and shell from snail shells fed with household organic waste. The study used a completely randomized design (CRD) method on 45 snails which were divided into 3 groups based on the organic waste, namely green mustard, long beans, and melon skin. The feed was given ad libitum for 4 weeks. Snail meat is taken on the last day and then tested for proximate composition. The snail meat and shell were made into flour. Daily feed consumption, body weight, meat and shell weight were measured statistically using ANOVA (sig.<0.05) and continued by the Duncan's test. Proximate tests of feed from organic waste, meat flour and snail shells were analyzed descriptively. The results showed that snails fed with long beans had a significantly high daily feed consumption rate (sig<0.05). The weight gain of snails fed with long bean and melon skins waste was 42.5% and 42,9% (sig<0.05). The percentage of meat from snails fed with long bean waste was 56.5%. The percentage of snail shells fed with mustard greens was 54.0% (sig<0.05). The shell yield of the mustard group, long beans and melon skins was 79,9%; 89,7% and 96,6%. It can be concluded that organic waste of long beans and melon skins results in good growth performance for intensively cultured snails. Organic waste from long beans is effective in increasing snail meat biomass. Mustard green waste effectively increases biomass production of snail shells.*

Keywords: *Achatina fulica*, chitosan, growth performance, organic waste, shell snail

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Introduction

Snails (*Achatina fulica*) are nocturnal animals that feed on many types of plants. According to the Global Invasive Species 2018 database, snails eat up to 500 types of crops including agricultural and plantation crops. From the results of the study, it is known that snails can eat leaves, petioles, fruits [1] and even fresh and rotten papaya tree trunks so it can be said that the feeding activity of snails is quite high [2].

The use of organic waste as feed in snail cultivation is something that needs to be studied further. Can feed from organic waste increase biomass production from snails? Giving feed in the form of organic waste to snails is something that is still rarely studied. Organic waste that causes environmental problems turns out to contain a lot of vitamin B-12, calories, protein, fat, fiber, lime, ash, iron, carbohydrates, and water where these elements can meet the nutritional needs of livestock [3], so that it can support the growth and development of animals that eat it.

The type and composition of the feed consumed determines the quality of growth and development of the cultured snail. Therefore, research is needed on how the growth performance of snails that are cultured and fed with household organic waste. Cultivated snails produce biomass that has a high economic value, namely meat and shell flour which have the potential to be used as raw materials in agroindustry and pharmaceuticals. The characteristics of meat and shell flour from snails need to be studied further to find out their quality, which is produced from snails fed with organic waste feed.

Methodology

This research was conducted from March-August 2022. Research activities including snail maintenance, body weight measurement, making meat flour and snail shells were carried out at the Animal Physiology Laboratory of the Biology Study Program FMIPA UNJ. Proximate tests from meat flour and snail shell flour were carried out at the Food Science and Technology Laboratory, Department of Nutrition and Food Technology, Faculty of Animal Husbandry IPB.

Experimental method and research group

The study was conducted using an experimental method with a design in the form of a Group Randomized Design (RAK). The free variable is in the form of giving 3 groups of organic waste feed, namely mustard green waste, long beans, and melon skins. The control group used wild snails. The bound variables are feed consumption, weight gain, meat, and shell weight yield and proximate of meat flour and shells from snail shells fed with organic waste.

Snail treatments

Snail (*Achatina fulica*) found in the yard of a house or plantation is selected with a length of 5-6 cm by 45 heads. Snails are kept in plastic cages measuring 40x60 cm with wire caps. Snails are fed according to the treatment group for 28 days. The composition of the feed given is as much as 80% organic waste and 20% commercial animal manure. The cage is kept humidity ranging from 80%-90% with a temperature of 23-28°C [4]. When the temperature rises can be maintained by spraying water with a volume of ±100 ml on the snail cage daily. Organic waste as feed is given ad libitum in the morning and evening for a 4-week treatment period. Keeping the snail cage area from being entered by other animals by putting a lid on the cage using a wire lid.

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Measurement of feed consumption and body weight

Feed consumption is the ability to spend the available feed ad-libitum. The amount of feed consumption is calculated from the amount of feed given minus the rest of the feed. Daily feed consumption is measured daily. The body of the snail is weighed once every 1 week.

Separation of snail meat and shell

On the 29th day the snail was fasted for 12 hours and then weighed its weight. Snails are cleaned of dirt and adhering soil and then boiled for 30 minutes to separate the shell from the meat. The separated meat and shell are then weighed using digital scales respectively. The percentage of wet weight of meat and shell to total body weight is obtained from the ratio of meat/shell weight per body weight multiplied by 100.

Processing flour from snail meat and shells

Meat and shells are removed from their water content by carrying out the drying process. The meat and shell are heated in the oven at 50 °C for 3-4 hours until the weight stabilizes. Then the meat and shell of snails are weighed and obtained dry weight value. The dried meat and shell are mashed with a mortar, then filtered with a 60-mesh filter so that meat flour and shells in powder form are obtained.

Proximate analysis of meat and shell flour

The three types of organic waste used in this study were analyzed for their proximate content. Water content is measured using the oven method, ash content by the drying method, protein by the Kjeldahl method, fat by the Soxhlet method, and crude fiber by the crude fiber method [5].

Data analysis

Data from proximate tests of organic waste, meat and snail shells were analyzed descriptively. Data on daily feed consumption, weekly weight gain, wet weight and dry weight of snail meat and shells were statistically analyzed by the ANOVA technique at $\alpha = 0.05$. If there are significant differences, continued by Duncan test with SPSS 25.00 series.

Results and discussion

Feed consumption and weight gain from snails fed with organic waste

Factors that can affect the growth of a cultured snail are the type of feed, the composition of the feed, and the amount of feed consumed. In this study, the feed given had a composition of 80% feed from organic waste and 20% commercial animal manure as a mixture and at the same time a source of minerals needed by snails. The results of daily feed consumption and weight growth for 4 weeks on snails fed 3 types of organic waste can be seen in Figure 1.

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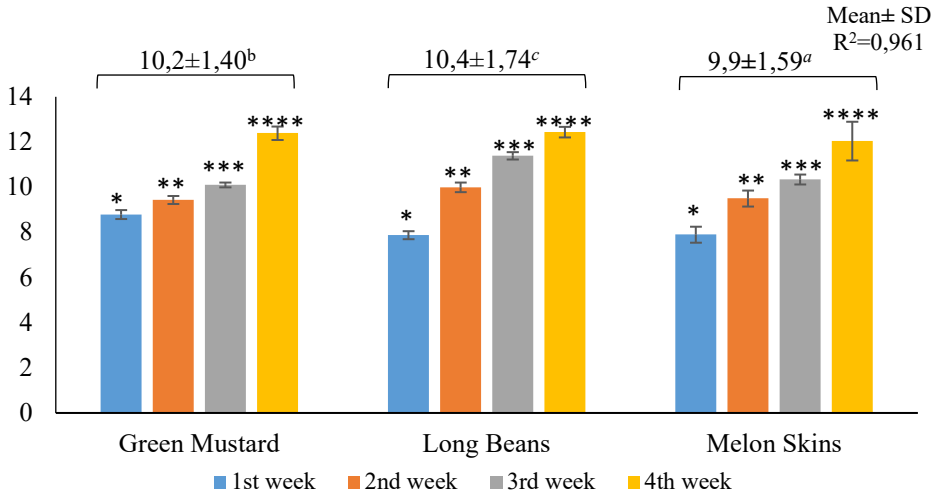


Figure 1. Daily feed consumption of snail fed with organic waste for 4th weeks. (*, a, b) the result of duncan's test p<0,05

Based on Figure 1 the daily feed consumption rate increases significantly every week (sig<0.05). This shows that of the three types of feed organic waste is edible and has good palatability for snails. However, by type of feed from organic waste shows that the average consumption rate differs significantly (sig<0.05). The consumption rate from snails fed with organic waste in the form of melon skins has a significantly low from the others (sig<0,05). This is allegedly due to the content of organic matter and the composition of the melon peel so that the daily consumption rate of snails is low. The level of feed consumption of organic matter is influenced by feed preferences, feed palatability, and the content of nitrogen-free extracts from feed ingredients given [6]. Therefore, it is necessary to measure the proximate of the feed from the organic waste used in this study. The proximate content of organic waste feed given in this study can be seen in Table 1 below.

Table 1. Proximate analysis of feed from organic waste given to snails (*Achatina fulica*)

Types of Feed	Water (%)	Ash (%)	Crude Fat (%)	Crude Protein (%)	Crude Fiber (%)
Green Mustard	13,37	16,74	1,88	32,40	8,51
Long Beans	11,58	6,71	2,02	23,00	8,73
Melon Skins	20,56	15,94	1,40	12,06	22,32

From Table 1, it is known that mustard greens and long beans have a high protein content of 32.40% and 23%, respectively. The crude protein content from melon skin waste is low at only 12.06% but has very high crude fiber compared to the other two types of waste, which is 22.32%. The high content of crude fiber is suspected to be the cause of the low daily feed consumption rate of snails. Crude fiber is a collection of all indigestible fibers. Crude fiber mostly contains cellulose, pentose and lignin derived from plant wall cells [7] making it difficult to digest and causes the digestibility rate of feed to be low and slow. High dietary crude fibre (CF) levels usually had a negative impact on feed utilization [8]. The slow rate of digestibility of feed causes the rate of emptying of the gastrointestinal tract to also be slow, resulting in low feed consumption rates.

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Crude protein is a component needed by the body for the growth of animals. The high protein content found in mustard greens and long beans is sufficient for snail needs for optimal growth. One of the important growth parameters in snail cultivation is the increase in body weight. Therefore, it is necessary to measure the growth of snails through weight gain of snails fed with organic waste for 4 weeks of the study period.

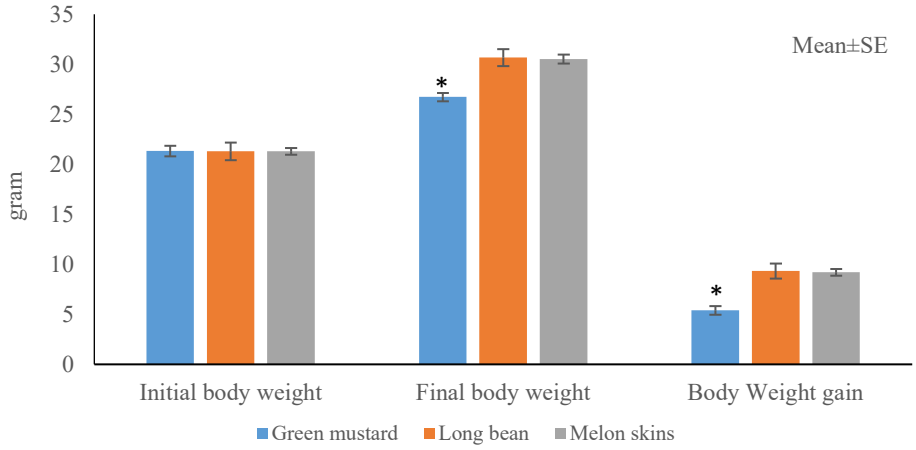


Figure 2. Weight gain of snails fed with organic waste for 4 weeks (*) The result of Duncan's test p<0,05

The growth performance of snails fed with feed from organic waste can be known from Fig 2 that the initial body weight in all groups of snails is uniform. After 4 weeks, there is a significant difference in the final body weight and weight gain of snails (sig<0.05). Significant high weight gain in the group of snails fed long beans and melon skins (sig<0.05). Meanwhile, the group of snails given mustard greens has a low weight gain (sig<0.05). This contrasts with the high rate of consumption of snails against mustard greens (sig<0.05) (Fig.1).

Table 2. The weight composition of meat and snail shells fed with organic waste for 4 weeks

Parameters	Green Mustard	Long Bean	Melon Skins	Control
Snail weight (gr)	248,0	249,8	210,0	200,0
Meat weight (gr)	96,0	141,0	104,0	99,1
% Meat weight	**38,7**	**56,5**	**49,5**	**49,5**
Dry Weight of meat (gr)	28,0	38,5	28,2	20,4
% Dry Weight of meat	29,2	27,8	29,0	22,2
Shell Weight (gr)	134,0	84,8	88,0	80,6
% Shell weight	**54,0**	**33,9**	**41,9**	**40,3**
Dry Weight of the Shell (gr)	107,0	76,1	85,1	74,0
% Dry Weight of the Shell	79,9	89,7	96,6	91,9

*N samples = 15 snails

Growth in the gastropod nation consists of 2 types, namely meat growth and shell growth. Therefore, high feed consumption rates should be looked at specifically whether it is used for weight gain of meat or shells. In the cultivation of animals, feeding is adapted to the desired production goals. The main production of snail cultivation is whole snails, snail meat, snail shells and mucus produced from snail meat. Snails that are cultured for meat and shells as raw

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materials for animal feed must be considered the quality of the feed given. The quality of the feed depends on the composition of nutrients, such as proteins, carbohydrates, and fats for growth [9]. Protein is an important ingredient as the main source of body composition [10]. The quality of snail products is closely related to the composition of the whole body, namely meat and shell. Therefore, it is necessary to look at the composition of snails against the growth of meat and shell as in the above Table 2.

In this study, the highest percentage of meat weight was produced successively by snails fed with long beans (56.5%), melon skins (49.5%) and mustard greens (38.7%). Meanwhile, in the control group of wild snails that were not kept, meat was obtained by 49.5% of the total weight of snails. The high percentage of meat from snails fed with long beans is due to the significantly high daily feed consumption of snails against long beans (sig<0.05) (Fig.1) and the high content of string beans fat (2.02%) and protein (23%) (Tab 1). Research results [11] state that the composition of fats and proteins in feed can increase the amount and quality of muscle mass. The availability and quality of feed in snail cultivation will accelerate the growth and survival of the animals that eat it [12]. This research proves that the provision of organic waste of long beans as feed is proven to increase the amount and quality of snail meat produced.

The composition of the shell to the body weight of snails is sequentially produced by snails fed with 54% mustard green feed: melon peel 41.9% and long beans 33.9%. When compared to the control group that produced a shell weight of 40.3%, mustard-fed snails produced a higher shell weight. The high shell weight in snails given mustard greens is due to the high protein content of 32.4% in mustard greens. Proteins in feed are used for cell regeneration, skeleton growth, and body immunity [11]. It was proven in this study that feeding garbage from mustard greens for 4 weeks resulted in the highest shell weight compared to long beans and melon shells. The composition of meat and shells produced from snails fed with organic waste feed is the basis for further research to see the quality of meat and shells that will be further processed for industrial needs.

Conclusion

The conclusion of this study is that organic waste can be used as the main feed from snail cultivation. Organic waste of long beans and melon skins results in good growth performance for intensively cultured snails. Organic waste from long beans is effective in increasing snail meat biomass. Mustard green waste effectively increases biomass production of snail shells.

Acknowledgments

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Characteristics of chitosan from shells of snail (*Achatina fulica*) fed with organic waste

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Abstract. *Organic waste can be used as feed for cultivation snails. One of the products that has the economic value of snail cultivation is the shell. Snail shells as a source of chitosan to be used in the medical and pharmaceutical industries. Therefore, this study aims to determine the characteristics of chitosan from snail shells fed with organic waste. The research method uses a complete randomized design (CRD). A total of 45 snails are divided into 3 groups based on the type of feed, namely mustard greens, long beans, and melon skins. The feed was given ad libitum for 4 weeks. Snail shells are taken on the last day and then made into flour. Shell flour is processed into chitosan by the method of chitin deacetylation. The percentage of yield and characteristics of chitosan were measured by Fourier Transform Infrared Spectroscopy (FTIR) and analyzed descriptively. The degree of deacetylation of chitosan is calculated from the FTIR curve. The results showed that chitosan yield in this study were successively obtained from melon skin 45,32%; mustard greens 44,97% and long beans 41,59%. The degree of deacetylation was obtained from snail shells fed with long bean 18,10%; mustard greens 17,45% and melon skin 6,45%. The chitosan spectrum produced from snail shells fed with organic waste was in wavenumber 3414,57-859,59 cm -1. It can be concluded that organic waste from string beans and mustard greens can increase the degree of deacetylation of chitosan from snail shells. It is necessary to proceed to find a method that can increase the degree of deacetylation of chitosan to reach values that correspond to the standards of industrial raw materials.*

Keywords: *Achatina fulica*, chitosan, FTIR, organic waste, snail shell

Introduction

Waste is one of the big problems especially in big cities around the world. In Indonesia, the high amount of waste is caused by community behavior and waste management that is still not effective in reducing waste production. The composition of waste is divided into several types including organic waste as much as 60%, plastic waste 15%, paper waste 10%, and metal, glass, cloth, and leather as much as 15% [1]. Organic waste can be used as material for making

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compost, but it can also be used as animal feed. One of the animals that is known to eat organic waste from market and household waste, for example vegetables and fruits, is snails.

In Indonesia, snails are still rarely cultivated by the community intensively. This is due to the lack of public knowledge about the potential that can be developed from snail-cultivated products. Snail-cultivated products have high economic value such as meat and meat flour, shell and shell flour and mucus from snails which have begun to be widely researched and developed in the fields of industry, biomedicine, and pharmaceuticals.

Snail shells are known to contain chitin and chitosan (2) which have high economic value and wide function of use in the field of cosmetics, food preservatives, and to overcome pollution. The chitin and chitosan produced will be carried out a characterization process to determine the quality of chitin and chitosan produced. These characteristics include physical and chemical properties in the form of amendments, moisture content, ash content, color, and smell. Furthermore, the characteristics of chitin and chitosan will be compared with the quality standards of chitin and chitosan in industry (3).

Chitin and chitosan are known to be obtained from the shells or exoskeletons of invertebrate animals such as mollusks, crustacea and insects. Shell snail contains about 70-80% more chitin compounds when compared to shrimp there is chitin as much as 15%-20% (4) and crab 20% - 30% (5) Chitosan snail shell chitosan has been widely studied for its activity as a heavy metal bio-adsorbent (6), animal feed supplements (7), natural preservatives (8), and antibacterial (9). There have not been many reports of chitosan products cultivated by snails which are given the main feed in the form of organic waste. Therefore, it is necessary to research to find out the characteristics of chitosan from the cultured snail shell by utilizing organic waste as a source of feed.

Methodology

This research was conducted from March-August 2022. Snail maintenance activities and the manufacture of chitin and chitosan are carried out at the Animal Physiology Laboratory of the Biology Study Program FMIPA UNJ. FTIR (Fourier Transform InfraRed) analysis of chitosan snail shells were carried out at the Laboratory of the Center for Biopharmaceutical Studies LPPM IPB University.

Experimental method and research group

This study was conducted using an experimental method with a Group Randomized Design (GRD) design with 3 types of organic waste as snail feed, namely mustard greens, long beans, and melon skins. The observation parameters are in the form of characteristics of chitin and chitosan resulting from the treatment carried out for 4 weeks. The treatment group consisted of mustard greens (MG), long beans (LB), melon skins (MS) and controls (C). The treatment is carried out by giving organic waste from the rest of the market as feed given ad libitum, and commercial animal manure.

Snail treatments

Snails with a length of 3-4 cm and a weight of 20-21 grams are selected and put in cages for the acclimatization stage. Acclimatization is carried out with the aim of adjusting habitat conditions for snails before the treatment stage. This process lasts for 5 days. The temperature is maintained between 23-28°C and the humidity around 80-90% (10) is maintained by adding water to the base and sides of the cage. Organic waste as feed is given ad libitum in the morning and evening

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for a 4-week treatment period. Snail cage to be given a wire lid so that it is not entered by other animals.

Separation of the shell from the body of the snail

Snails on the 29th day were satisfied 12 hours and then weighed in weight. Shell retrieval is carried out by boiling the snail in advance for 30 minutes to separate the shell from the meat. The obtained shell is then weighed using digital scales. The moisture and ash content of the shell was analyzed proximately by the AOAC method (11).

Flour preparations from snail shells

The preparation stage is carried out by drying the shell using an oven at 50°C for 3-4 hours until the weight of the shell stabilizes. Furthermore, the shell is mashed using a mortar and filtered with a 60-mesh filter so that shell flour is produced.

Making chitosan from snail shell flour

Deproteination

Snail shell flour was mixed with a 3.5% NaOH solution in a ratio of 1:10, then heated in 65°C while stirring using a magnetic stirrer for 2 hours. After that it is allowed to cool, proceed with the neutralization process using water. The solids are then dried in the oven at 60 °C.

Demineralization

Snail shell flour is put in a beaker glass of 500 ml, then it is added with a solution of HCl 1 N in a ratio of 15:1. The mixture is heated for 30 minutes while stirring at 40 °C then cool. After that it is filtered and neutralized its pH with water followed by drying at a temperature of 60 °C.

Depigmentation

Shell flour is mixed with a 0.315% solution of NaOCl in a ratio of 1:10 in a glass of 250 ml. heated to 40 °C for 1 hour while stirring. After that, the result is filtered and neutralized using water, followed by a drying process using an oven at a temperature of 80 ° C.

Deacetylation

Chitosan is made from the deacetylation of chitin using the method of ([11]2). Deacetylation of chitin is carried out by dissolving chitin in NaOH in a ratio of 1:20. The concentration of NaOH used is 60%, heated using a magnetic stirrer for 1 hour at a temperature of 100-140 °C. The resulting residue is rinsed using water to a neutral pH, then dried using an 80°C oven for 24 hours. Further analyzed using the infrared spectrophotometer method.

Chitin and chitosan analysis

The yield of chitin is calculated by dividing the weight of chitin by the initial weight and multiplied by 100% according to the following formula.

$$\text{Amendments} = \frac{\text{chitin weight}}{\text{dry weight of the shell}} \times 100\%$$

The moisture content is determined by putting as much as 2 grams of chitin into a porcelain dish of known weight, then the dish is put in an oven with a temperature range of 102-105 °C until dry. After that, cooling is carried out by transferring the saucer from the oven to the desiccator. The saucer is weighed, and the moisture content is calculated by the following formula.

$$\%\ \text{Moisture} = \frac{\text{initial chitin weight-final chitin weight}}{\text{initial chitin weight}} \times 100\%$$

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Ash content is analyzed by the principle of calculating the weight of minerals produced from the process of burning organic matter at a temperature of 550 °C before being placed in *furnace*. The first step is that the sample is heated at 550°C for 1-2 hours until the lowest moisture content until white ash forms. Next the sample is removed and put in a desiccator to cool, then weighed until it acquires a constant weight. The ash content is calculated by the following formula.

$$\% \text{ Ash} = \frac{\text{ash weight}}{\text{chitin weight}} \times 100\%$$

The solubility of chitin is carried out by dissolving as much as 1 gram of chitin in 50 ml of 2% acetic acid, put in a Beker glass and stirred. The percentage of solubility is determined by the ratio of the remaining chitin to the initial chitin.

Chitosan characterization in the form of deacetylation degree and amendment. The degree of deacetylation was carried out by analysis using FTIR on IR-408. The degree of chitosan deacetylation is measured based on a curve from a spectrophotometer analysis. The percentage of the degree of deacetylation is calculated using the following formula

$$\%\text{N-deacetylation} = \left[1 - \left[\frac{A1{,}655}{A3{,}450} \times \frac{1}{1{,}33}\right]\right]$$

$A_{1,655}$ = Absorbance at wavelengths 1,655 cm^{-1}

$A_{3,450}$ = Absorbance at wavelengths 3,450 cm^{-1}

1,33 = Constants for the perfect degree of deacetylation

Data analysis

Chitosan characteristic analysis in the form of instrumentation analysis using the FTIR (Fourier Transform Infra-Red) spectrophotometer. Data on the percentage of moisture content, ash content, nitrogen content, degree of deacetylation of chitosan and the yield of chitin and chitosan were analyzed descriptively.

Results and discussion

Chitin from snail shell flour is obtained through the process of deproteination and demineralization. The purpose of these two processes is to secrete protein as the main constituent of the shell and inorganic calcium carbonate (13). Furthermore, the pigment removal process by the depigmentation method to produce colorless chitin. Chitin is then deacetylated with NaOH solution to obtain chitosan. Chitosan amendments are calculated and presented in Table 1.

Table 1. Chitin and chitosan shells from snails fed with organic waste for 4 weeks

Group	Shell flour (gr)	Chitin		Chitosan	
		gr	%	gr	%
Control	79,05	40,04	50,65	39,12	49,49
Mustard Greens	80,50	36,75	45,65	36,20	44,97
Long Beans	95,75	40,84	42,65	39,82	41,59
Melon Skin	90,25	41,74	46,25	40,90	45,32

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Snail shell chitosan amendments in this study were successively obtained from the control group (49.49%); melon peel (45.32%); mustard greens (44.97%) and long beans (41.59%). Another study resulted in a chitosan yield from snail shells of 6.95% (12). The amount of chitosan yield produced is influenced by the type of fish used. In addition, the amount of amendment obtained is also influenced by the concentration of NaOH and the duration of soaking in the process of deacetylation of chitin into chitosan (14). The characteristics of chitosan produced from snail shells fed with organic waste for 4 weeks can be seen in Table 2.

Table 2. Characteristics of snail shell chitosan fed with organic waste for 4 weeks

Specifications	Control	Mustard Greens	Long Beans	Melon Skins
Color	White-brown	White-brown	White-brown	White-brown
Smell	Odorless	Odorless	Odorless	Odorless
Shape	Crystal	Crystal	Crystal	Crystal
Moisture Content	0,16	0,18	0,19	0,19
Ash Content	96,53	96,10	95,97	96,34
Solubility	70%	75%	75%	70%
Degrees of deacetylation	11,16	17,45	18,10	6,45

The degree of deacetylation can be determined volumetrically or using infrared spectroscopic instruments. In this study, the value of the degree of deacetylation was obtained from snail shells fed with long bean waste feed (18.10%); mustard greens (17.45%); control (11.16%) and melon peel (6.45%). This proves that feeding from organic waste in the form of string beans and mustard greens can increase the degree of deacetylation of snail shell chitosan. However, the value of the degree of deacetylation of chitosan in this study still does not meet the commercial standard of chitosan for the industry, which is >70% (15).

The minimum chitosan deacetylation degree standard for the food industry is 70%, the cosmetics industry is 80% and the biomedia industry is 90% (12). Factors that affect the degree of chitosan deacetylation include the concentration of NaOH in chitosan isolation, temperature, and time of the chitosan deacetylation process (14). More research is still needed to find the right method to increase the degree of deacetylation of chitosan in snail shells.

Characterization of chitosan can use different techniques like spectral analysis, X-ray diffraction, Elemental analysis, Fourier transforms infrared spectroscopy (FTIR), Scanning electron microscopy (SEM) and Differential scanning calorimetry (DSC). The FTIR patterns displayed the bands corresponding to stretching and vibration of O-H, N-H and CO bonds and conformed the formation of α-chitin. Degree of deacetylation (DD) value was calculated using elemental analysis, potentiometric titration and FTIR (16). The results of d the FTIR analysis of Chitosan Snail Shells fed 3 types of organic waste can be seen in Figure 1.

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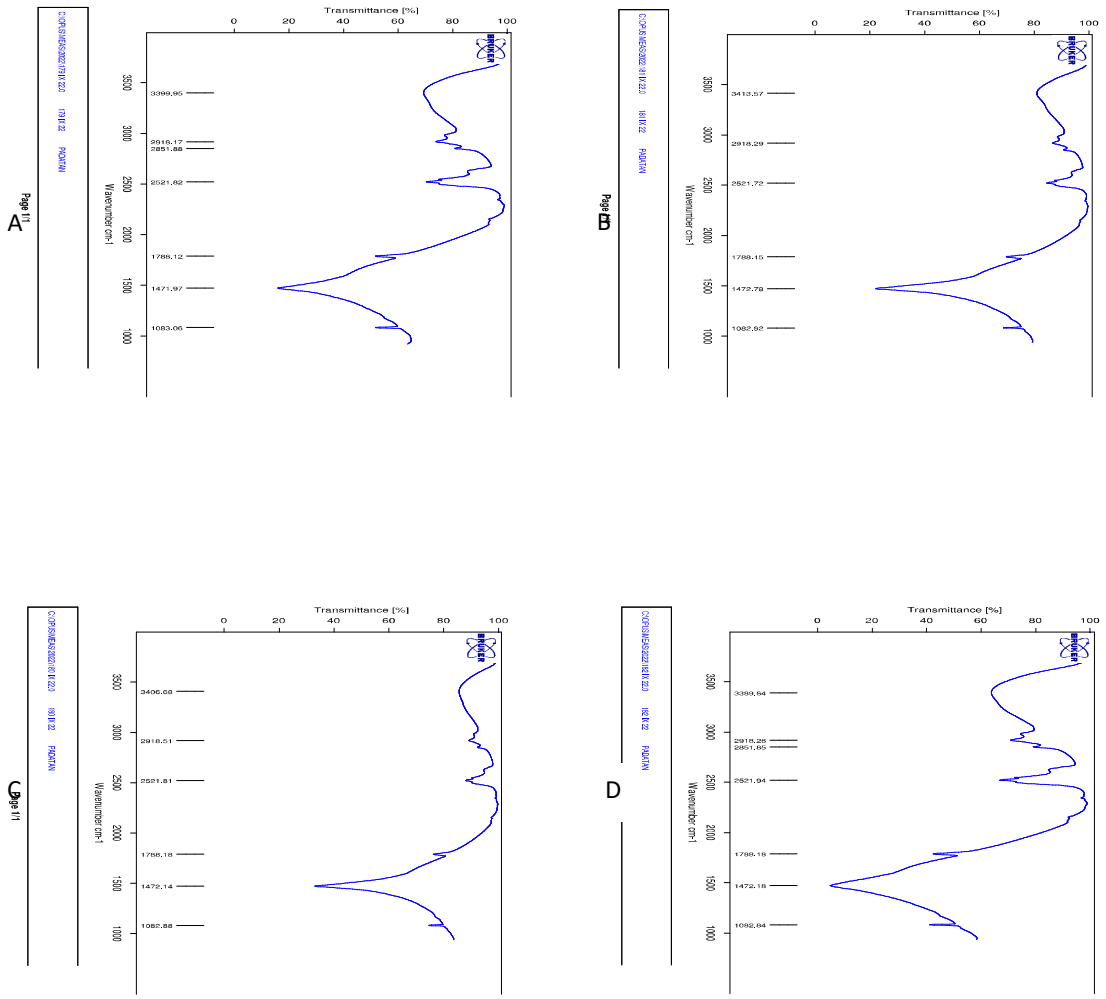


Figure 1. The results of the FTIR analysis of chitosan snail shells fed with (A) control; (B) mustard greens; (C) long beans; (D) melon skin

In this study, the curve pattern and absorbance value the wavelength of the control group (A) is like the melon skin group (D), meanwhile, the mustard green group (B) is like the long bean group (C). the absorption pattern in the wave numbers of group A is alike D, while group B is the same as C. Characterization of the chitosan spectrum in Table 3.

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Table 3. Characterization of the chitosan FTIR spectrum from snail shells fed with organic waste for 4 weeks

No.	Functional Groups	Wavenumber (cm $^{-1}$)				
		Standard*	Control	Mustard green	Long Bean	Melon skin
1.	O-H bending vibration overlaps N-H	3377,95	3399,95	3413,57	3406,68	3389,64
2.	stretch vibration	2922,80	2918,17	2918,29	2918,51	2918,26
3.	Aliphatic C-H symmetrical stretch	1660,55	1788,12	1788,15	1788,18	1788,18
4.	vibration	1422,73	1471,97	1472,78	1472,14	1472,18
5.	C=O stretch vibration	1077,93	1083,06	1082,92	1082,88	1082,84
6.	C-H stretch vibration	897,41	859,59	860,31	860,01	859,92
	O-C stretch vibration					
	β 1,4-glycosidic stretch out vibration					

*Dompeipen (2017)

Based on Fig 1 and Tab 3, the chitosan spectrum produced from snail shells fed with organic waste is in wave number 3414.57-859.59 cm -1. This range is wider than the standard at 3377,95-897,41 cm -1 (13). The bonds in reactive amine and hydroxyl chitosan groups in the region are between 3000 and 3800 cm-1 (17). In this study, amine and hydroxyl bonds in chitosan were produced at Wavelength 3389-3413 cm -1. Meanwhile, the absorption band in the aliphatic C-H symmetrical stretch vibration at 2918 cm -1; cluster C=O stretching vibration at 1788 cm -1; C-H stretching vibration at 1471 cm -1; O-C stretch vibration at 1082 cm -1 and β-1,4-glycosidic stretch out vibration group at 860 cm -1. The spectral regions derived from the absorption maxima associated with the amide band at 1660 and 1550 cm-1 and the amine band at 1600 cm-1 (18). The C =O function group in this study had the same value in all treatment groups, namely 1788 cm -1 including having a good absorption band. The absorption band at the number 1640 cm -1 means that the deacetylated C=O functional group is getting more and more. This proves that the method used can convert chitin into chitosan (14). It is necessary to conduct further research to find the right method to increase the degree of chitosan deacetylation suitable for industrial raw materials.

Conclusion

The conclusion of this study is that chitosan produced from snail shells fed with melon skin was 45.32%, mustard greens 44.97% and long beans 41.59%. The degree of deacetylation of chitosan shells from snails fed with long beans was 18.10%, mustard greens 17.45% and melon skins 6.45%. The spectrum range of FTIR analysis was generated on wavenumber 859-3413 cm -1.

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The effect of giving jamu TELAKU on creatine kinase levels in strenuous physical exercise

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Abstract. *Jamu TELAKU (TLK) is a traditional medicine from Indonesia which contains Temulawak (Curcuma zanthorrhiza) and Turmeric (Curcuma longa Linn) which is usually drunk as a health drink. Jamu TELAKU contains Curcumin which is efficacious as an antioxidant and anti-inflammatory. It is known that strenuous physical exercise can cause oxidative stress, muscle damage and inflammation. The objective of the study was to determine the effect of giving Jamu TELAKU on creatine kinase levels in rats that did strenuous physical exercise. Four groups of 12 male rats each were established formed from the 48 total male rats. Groups 1 and 2 did not exercise; Groups 3 did exercise but added TLK; and Group 4 did exercise but added TLK. TELAKU is given every day at a dose of 5.4 ml/kgBW for 6 weeks. After 6 weeks, all rats were asked to do strenuous physical activity by means of rats forced to swim. Subsequently, the creatin kinase level was measured through an enzyme-linked immunosorbent assay. The findings revealed that CK levels in group 4 were lower than those in group 1, 2, and 3, CK levels in group 3 were lower than those in group 1 and 2, CK levels in group 2 were lower than those in group 1 (p-value < 0.05). The findings of this study indicate that TELAKU supplementation may help prevent the muscular damage that is brought on by strenuous physical exercise.*

Keywords: jamu, TELAKU, creatin kinase, curcumin, oxidative stress, muscle damage, antioxidant, anti-inflammation

Introduction

Jamu is a traditional medicine that is provided traditionally which contains all the plant ingredients that make up the herbal medicine, hygienic (free of contamination) and used traditionally. For the people of Indonesia, herbal medicine is a recipe handed down from their ancestors so that they can be maintained and developed. The herbal ingredients themselves are taken from plants in Indonesia, both from roots, leaves, flowers, and bark. Herbal medicine plays an important role in traditional health care and will continue to take place in the midst of the development of modern medicine. The materials used do not contain synthetic chemicals but use a variety of plants that are taken directly from nature and the side effects are relatively smaller.

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One type of herbal medicine that is often consumed by people in Indonesia is Jamu Temulawak and Turmeric which contains ginger and turmeric rhizomes and is processed into drinks or made in capsule form.

In a previous study, Akinola et al. reported temulawak and turmeric extracts had the highest antioxidant activity compared to 10 species of plants from the Zingiberaceae family [1]. Apart from having antioxidant activity, temulawak and turmeric also have anti-inflammatory properties due to the curcumin content [2-5]. One of the causes of inflammation and oxidative stress is strenuous physical exercise and very tiring physical exercise. By activating Nuclear Factor kappa B (NF-κB) [6], which in turn causes an increase in inflammatory markers like C-reactive protein (CRP) and a number of inflammatory interleukins like interleukin (IL)-6, IL-8, IL-10, interleukin 1 beta (IL-1), and tumor necrosis factor (TNF-) [7,8], as well as an increase in the amount and activity of stress proteins, particularly Heat Shock Proteins70 (HSP70) [9].

Exercise-induced muscle damage (EIMD) and extreme tiredness [10–12] are additional side effects of strenuous physical activity. Physical activity-related muscle damage can result in localized swelling [13–15], decreased range of motion (ROM), delayed onset muscle soreness, and decreased muscle strength. It can also result in an increase in blood levels of muscle proteins like creatine kinase (CK), lactate dehydrogenase (LDH), and myoglobin (Mb) [16,17]. Because they are directly implicated in EIMD and extreme tiredness that results in a decline in performance for at least 24-96 hours [18], inflammation, oxidative stress, and muscle damage caused by vigorous exercise must be studied and controlled simultaneously.

Curcumin [2-5] is one of the natural substances with anti-inflammatory and antioxidant properties. The compound curcumin is present in the rhizomes of temu lawak and turmeric, and in Indonesia it is frequently incorporated into herbal remedies that are used as a health beverage. The herbal remedy TELAKU, which combines Temu lawak and turmeric, is one of the herbs that contains curcumin. This investigation looked at how TELAKU affected the levels of creatine kinase in rats that that did strenuous physical activity.

Methodology

This study has a post-test only control group design which is conducted in experimental research. 48 male rats who were 3–4 months old and weighed 180–200gr made up the sample. Prior to treatment, rats were acclimatized for 2 weeks by placing them in a cage. During acclimatization, the rats were fed in the form of pellets and drank at libitum. The purpose of this acclimatization is to standardize the way of life and food for the experimental animals used in the research. Ethical clearance was obtained from the ethics committee of FMIPA (the Faculty of Mathematics and Natural Sciences), Universitas Sumatera Utara with approval number 0405/KEPH-FMIPA/2022.

Experimental design

Four groups of 12 male rats each were established formed from the 48 total male rats. The rats in Group-1 did not do any exercise (No Exercise) while the rats in Group-2 did exercises. In addition, the rats in Group-3 did not do any exercise but they consumed TLK Supplementation (No Exercise + TLK Supplementation). The last but not the least, the rats in Group 4 were treated both did exercises and were given TLK Supplementation (Exercise + TLK Supplementation). TELAKU is given every day at a dose of 5.4 ml/kgBW for 6 weeks. The exercise group was carried out by swimming the rats 15 minutes every day in the first week. In the second Sunday, the rats

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swam for 20 minutes; 25 minutes in the third Sunday; 30 minutes per day in the fourth week; 35 minutes on the fifth week and 40 minutes on the sixth week. After 6 weeks, all rats were asked to do strenuous physical activity by means of rats forced to swim. Subsequently, the quantity of creatin kinase in the rats' body was determined using an enzyme-linked immunosorbent assay.

Blood sample collection

Blood samples were taken from the heart of rats as much as 3 ml using a syringe. Furthermore, the blood is divided into 2 by inserting it into a microtube containing 1% EDTA solution and examining RBC, Hb, WBC and PVC using a hematology analyzer. A small amount of blood was placed in a microtube and centrifuged at 2000-3000 RPM for 20 minutes. Furthermore, the resulting serum is stored in a refrigerator with a temperature of -800C to be used for checking CK levels.

Data analysis

IBM SPSS Statistics 25 was used to conduct the statistical analysis. Statistical analysis was carried out to see differences between treatments with the following steps:

a. Data Normality Test with Shapiro-Wilk at 95% confidence interval ($\alpha = 0.05$), which aims to determine the distribution of data. If the p value is less than 0.05, the data is said to be distributed normally, and vice versa.
b. Test the homogeneity of the data with the Levene Test at a 95% confidence interval ($\alpha=0.05$), which aims to determine the variance of the data. If the value of p is less than 0.05, the data is homogeneous; otherwise, it is not.
c. One Way Anova was used to assess the research variables and test the hypothesis with a 95% confidence level. Use the Tukey HSD test with a 95% confidence interval if there is a difference.

Results and discussion

Figure 1 displays the effect of the herbal supplement TELAKU on the levels of creatine kinase in rats during strenuous physical exercise. The concentration data were found to be normally distributed and homogenous with a p-value > 0.05 according to the results of the Shapiro-Wilk test for normality and the Levene test for data homogeneity. The one-way ANOVA test findings revealed that, with a p value 0.05, the CK levels in group 4 (Exercise + TLK Supplementation) were lower than those in groups 1 (No Exercise), 2 (Exercise), and 3 (No Exercise + TLK Supplementation). CK levels were lower in group 3 than groups 1 and 2, whereas group 2 had lower CK levels than group 1 (p-value < 0.05).

A bodily condition known as tissue damage impairs a tissue's ability to function. An imbalance in the synthesis of oxidants and antioxidants (oxidative stress) is one factor that causes tissue damage. The theory of free radicals [19] is one of the theories used to explain the incidence of tissue damage brought on by exercise. One of the indicators used as signs of tissue damage is creatine kinase (CK). Creatine kinase is an enzyme that plays an important role in the energy system during exercise. Under normal conditions, creatine kinase is found in the mitochondria, if the amount of creatine kinase in the blood increases, it is an indicator that muscle damage has occurred. High levels of creatine kinase are an indicator of chronic disease or acute muscle injury [20].

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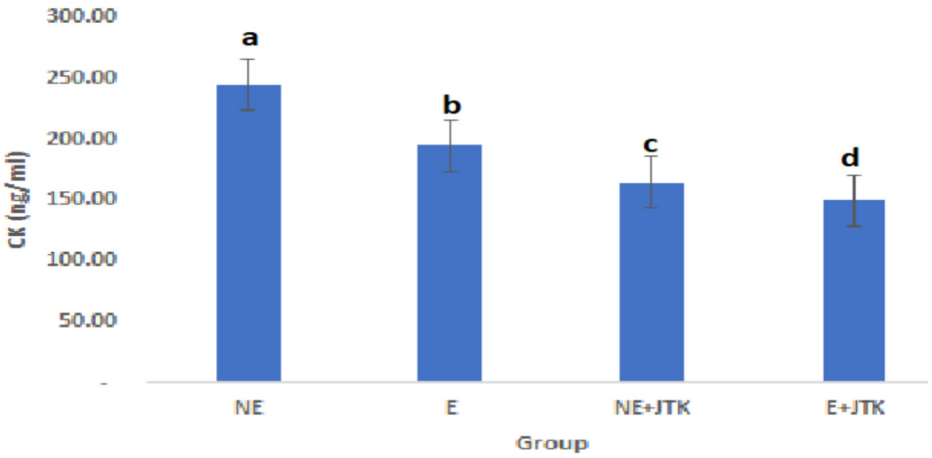


Figure 1. The effect of giving Jamu TELAKU on the levels of creatine kinase levels in rats who do strenuous physical exercise

Figure 1 shows the effect of administering Jamu TELAKU on the levels of creatine kinase in rats engaged in strenuous physical activity. The group of rats in Figure 1 that did not exercise, were not given Jamu TELAKU, and engaged in strenuous physical activity had the highest levels of creatine kinase. Due to the high amounts of creatine kinase in this group brought on by intense physical exercise, free radical generation may increase, producing more than antioxidants, leading to oxidative stress. Creatine kinase levels can rise as a result of oxidative damage brought on by strenuous physical activity [19]. The findings of a study conducted by Sinaga, et al. [21] provide support for the findings of this investigation. However, the increase in creatine kinase levels in group 2 was not as significant as the increase in group 1's. Creatine kinase levels increased in both groups. This is because the regular exercise performed by group 2 for 6 weeks led to adaptation, which made the increase in creatine kinase levels in group 2 less pronounced than in group 1 when the rats engaged in vigorous physical activity. The findings of a study by Draganidis et al., which found that exercise increased creatine kinase levels to a point where they peaked 24 hours after exercise in the moderate-intensity exercise group and 48 hours after exercise in the high-intensity exercise group, support the findings of the present study [22]. In a research by Cerqueira et al., elevated CK levels were also noted, with the peak 24 hours after intense exercise [23].

In group-3 there was a decrease in CK levels when compared to CK levels in group-1 and group-2. The decrease in CK levels in group-3 was due to the daily administration of Jamu TELAKU at a dose of 5.4 ml/kgBW for 6 weeks. It is known, Jamu TELAKU is an Indonesian traditional medicine that contains temu comedy and turmeric which is rich in curcumin. It is known that curcumin is a compound that has antioxidant and anti-inflammatory properties. The greatest decrease in CK levels was in group-4, namely the group that did exercise for 6 weeks and consumed Jamu TELAKU at a dose of 5.4 ml/kgBW. It is known, exercise that is done regularly with gradually increasing intensity can increase the body's antioxidants. In this study, the combination of regular exercise with increasing intensity and consuming Jamu TELAKU during exercise can reduce increased levels of CK in rats that do strenuous physical activity. Jamu TELAKU which contains Curcumin will counteract free radicals that are formed during rats doing strenuous physical activity. The antioxidant activity and free radical reactions of curcumin are closely related to the phenolic O-H and C-H which suppress the activity of reactive oxygen species

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(ROS) produced during muscle contraction that normally contribute to muscle damage through the release of CK [24]

Curcumin is a highly pleiotropic anti-inflammatory chemical which is able to interact with a variety of target molecules related to inflammation. Curcumin controls the inflammatory response by decreasing the activity of cyclooxygenase-2 (COX-2), lipoxygenase and induced nitric oxidation synthase (iNOS) enzymes, inhibiting the production of inflammatory cytokines tumor necrosis factor alpha (TNF-a), interleukin (IL)-1, - 2, -6, -8 and -12, migration inhibitory proteins, reduce mitogen-activated protein and monocyte chemoattractant protein (MCP) [25]. Inhibition of COX-2 and iNOS may occur because curcumin inhibits nuclear factor-kappa B (NF-kB). NF-kB is involved in the regulation of inflammation, cell proliferation, transformation and tumor formation. Curcumin is thought to suppress NF-kB activation and proinflammatory gene cell expression by blocking phosphorylation of inhibitory factor I-kappa B kinase (IkB). The expression of COX-2 and iNOS may be reduced, inflammatory processes and tumor growth may be inhibited, and prostaglandin release [26] may be decreased by Suppressing NF-κB activation. As a result, it reduces muscle damage. Creatine kinase (CK) is released during exercise and produces prostaglandins under the control of COX-2, which increases membrane permeability and denotes muscle injury [27] by moving via the lymphatic system and into the interstitial fluid.

The decrease in creatine kinase levels due to the administration of Jamu TELAKU in this study was supported by several studies that reported the administration of curcumin before undergoing exercise or during an exercise program or after physical activity. A study by Nakhostin-Roohi, B., et al. who administered 150 mg of curcumin to ten healthy young men (age, 25.0 ± 1.6 years; height, 178.9 ± 4.1 cm; body mass, 81.1 ± 6.8 kg; % fat, 14.2 ± 2.1) after doing intensive eccentric exercise reported that administration of curcumin at a dose of 150 mg can reduce CK levels compared to the control group [28]. Administration of curcumin for 7 days in untrained men at a dose of 180 mg (90 mg given twice daily at breakfast and dinner) was reported to reduce CK activity when compared to the placebo group [29]. The results of a study conducted by Tanabe Y., et al reported that administration of 300 mg of curcumin (Theracurmin) in divided doses (150 mg 1 hour before the one-leg jump performance exercise and 150 mg 12 hours after the single-leg jump performance exercise) showed peak CK activity in the curcumin group was significantly smaller (3398 ± 3562 IU/L) compared to the placebo group (7684 ± 8959 IU/L) [30]. Creatine Kinase activity was also lower at 48, 72 and 96 hours compared to baseline CK levels. Oral curcumin supplementation at a dose of 400mg/day (Longvida®400 mg/day) in an eccentric-only dual-leg press exercise, plus supplementation two days before exercise and 4 days after exercise resulted in a much smaller increase in CK levels (-48 %) when compared with the placebo group [31].

Conclusion

The findings of this study suggest that using TELAKU supplements can reduce the muscular damage brought on by strenuous physical exercise.

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Influence of rootone F to growth cuttings bud andaliman (*Zanthoxylum acanthopodium DC*) at plant cultivation the quality of export

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Abstract. *This study aims to know effect rootone F to growth cuttings bud Andaliman (Zanthoxylum acanthopodium DC.) to plant cultivation of export. This reseach use Completely Random Design (CRD) with 6 treatment (0, 100, 200, 300, 400, 500 mg/l) and 10 replications. Data use analysis of variant (Anova) 5% and 1% to know influence treatment, and post hoc test DMRT (Duncan Multiple Range Test) 5% to know difference treatment. Parameter observed is amount of cuttings bud of life, time shoots, amount shoots and amount leaf. Result of research show there is influence highly significant toward parameter amount of cuttings bud of life and time shoots because F count > F table 5% and 1%. While for parameter amount shoots and amount leaf non-significant because F count ≤ F table 5% and 1%. Post hoc test DMRT 5% for parameter influence highly significant is amount of cuttings bud of life and time shoots difference treatment. Result post hoc test DMRT 5% at parameter amount of cuttings bud of life show that treatment PO (without rootone F) significant by treatment P2, P4, P6, P8, P10 (with rootone F), value highest at treatment P10 is 1,169 cuttings bud of life. Parameter time shoots, treatment P8 and P10 significant by P0, P2, P4 and P6. Value short in time shoots is treatment P8 and P10 is 19 and 19,5 days respectively. Parameter non-significant is amount shoots and amount leaf not post hoc test DMRT 5%, but there is negative correlation by value r = - 0,794 (correlation very strong).*

Keywords: rootone F, cuttings bud, andaliman, plant cultivation, quality export

Introduction

Andaliman (*Zanthoxylum acanthopodium* DC) is a spice/condiment-producing plant used by several communities, especially the Batak community [1]. Batak people usually use andaliman for cooking special foods such as saksang, naniura, nanigotaan and naniarsik so that it adds a delicious taste and distinctive aroma to food, where this spice is only known in Batak cuisine, so many know it as Batak pepper [2].

In addition to cooking spices, Andaliman is a medicinal ingredient because Andaliman fruit contains flavonoids and polyphenols, which have antioxidant and antimicrobial activity [3]. The sensation produced by consuming Andaliman feels bitter on the tongue due to the presence of the compound hydroxy alpha sanshool. This plant has a soft citrus-like aroma that adds to the appetite. Most of the andaliman fruit is rich in oil which contains large amounts of alkaloids and unsaturated fatty acids that have a role as an antioxidant [4].

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The results of observations of Andaliman farmers around Lake Toba concluded that there were fundamental problems faced, namely plant cultivation and Andaliman prices fluctuated). Cultivation problems, especially in propagation, usually Andaliman propagation can be done by seed, but it has not been maximized because of many obstacles encountered in the field. The solution is vegetative propagation through the grafting method and the cutting method. The results of previous studies stated that the shoot-cutting method was more successful than the stem-cutting method [5].

Propagation of plants by cuttings needs to pay attention to the parent tree as a source of cuttings to produce plants as desired. Selection of parent trees needs to be carried out so that the supply of shoots can take place well and of export quality (a result of discussions with exporters and Belawan quarantine officers).

Rootone F is a synthetic growth regulator (ZPT) that induces root formation from shoot cuttings [5]. The active ingredient of rootone F is a combination of IBA and NAA, which is very effective in stimulating the shoots and root growth of cuttings [6]. According to [7], IBA, such as IAA, is a group of auxin hormones mostly produced by plants. NAA is an artificial hormone of IAA and is not produced by plants but has the work power of auxin.

Methodology

Location and time of research

The research was conducted in Eden Garden 100 Lumban Julu District Toba Regency. The research period is from April to November 2022.

Population and sample

The population is all Andaliman plants found in Eden Gardens 100. Then samples are taken based on export criteria: healthy plants, fruit colour light green to blackish brown, a maximum of 1-2 cm stems, free from other by-products (such as soil, stalks, stems and leaves), not mouldy and free from insects, required documents (phytosanitary certificate and certificate of origin).

Tools and materials

The tools used in this study were polybags, crop scissors, plant knife, analytical balance, beaker glass, erlenmeyer, measuring cup, dropper, bucket, rag, label paper, tape, calliper, 30 cm ruler and other stationery. The materials used in this study were cocopeat media using a flute, andaliman shoots from Eden Garden 100, Lumban Julu District, Toba Regency, North Sumatra.

Research design

This study used a completely randomized design with six treatments (0, 100, 200, 300, 400, and 500 mg/l) and each treatment with ten replication. Analysis of Variance (ANOVA) was used to determine the effect of treatment, if the treatment had an effect, then proceed with the 5% DMRT test to determine the difference between treatments.

The number of replication for each treatment group is obtained from the Federer formula, namely:

$(t-1)(n-1) \geq 15$

$(6-1)(n-1) \geq 15$

$5n - 5 \geq 15$

$n \geq \frac{20}{5}$

$n \geq 4$ replication

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Description: t = Number of treatments
n = Number of replications

Based on Federer's formula above, there are at least 4 replication, but in this study 10 replication were carried out. The experiment was carried out with six treatments, each repeated 10 times so that there were 60 experimental units. The linear model for a completely randomized design can be written as follows:

$Y_{ij} = \mu + \gamma_i + \beta_j + \varepsilon_{ij}$

Dimana :

$Y_{i\,j}$ = Observation value of treatment on i and replication on j
μ = General average
γ_i = Effect of treatment on i
β_j = Effect of treatment on j
ε_{ij} = Random effect of treatment on i and replication on j

Parameter

Parameters observed were: 1) the number of live cuttings, 2) the time (days) when shoots began to appear, 3) the number of shoots and 4) the number of leaves.

Data analysis

The data obtained from the study are presented as a table and then analyzed using Analysis of Variance (ANOVA).

Table 1. Analisis of Varian (ANOVA)

SK	Db	JK	KT	Fcount	Ftable 5%	Ftable 1%
Treatment	t-1	JKP	KTP	$\frac{KTP}{KTG}$		
Error	(t-1)(r-1)	JKG	KTG	-	-	-
Total/General	rt-1	JKT	-	-	-	-

Note: SK = Source of Diversity, db = degrees of freedom, JK = Total Square, KT = Middle Square, t = Treatment, r = Replication.

The replication used the Federer formula: (t-1)(r-1) 15, with the number of treatments 6, so the minimum number of replications was 4 in order to meet the statistical requirements (in this study 10 replication were used). If F count > F table 5% and 1%, it means that there is a real and highly significant effect of the treatment, it is necessary to carry out further DMRT (Duncan Multiple Range Test) 5% test to determine the difference between the treatments with the formula:

$$\text{DMRT} = R_{\alpha,p,v}\sqrt{\frac{\text{KTG}}{\text{r}}}$$

Keterangan :

$R_{\alpha,p,v}$ = The actual critical value of the test
α = Real level
p = Distance
v = Degree of freedom
KTG = Middle Square Error
r = Replication.

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Results and discussion

The number of live shoot cuttings

The number of live shoot cuttings of Andaliman (*Zanthoxylum acanthopodium* DC) for the cultivation of export quality plants Simanuk at 42 DAP (Days After Planting) is shown in Table 2.

Table 2. Number of live cuttings of andaliman simanuk (*Zanthoxylum acanthopodium* DC) aged 42 DAP with rootone F treatment on data transformation √(x+0,5)

Num.	Replication	Treatment					
		P0	P2	P4	P6	P8	P10
1	U1	1,22	1,22	1,22	1,22	1,22	1,22
2	U2	0,71	1,22	1,22	1,22	1,22	1,22
3	U3	0,71	0,71	1,22	1,22	1,22	1,22
4	U4	0,71	1,22	1,22	1,22	0,71	0,71
5	U5	0,71	0,71	0,71	1,22	1,22	1,22
6	U6	0,71	1,22	1,22	1,22	1,22	1,22
7	U7	0,71	1,22	1,22	1,22	1,22	1,22
8	U8	1,22	1,22	1,22	0,71	0,71	1,22
9	U9	0,71	0,71	1,22	1,22	1,22	1,22
10	U10	0,71	1,22	0,71	1,22	0,71	0,71
Total		8,12	10,67	11,18	11,69	10,67	11,18
Average		0,812	1,067	1,118	1,169	1,067	1,118

Description: P1 = 0 mg/l, P2 = 100 mg/l, P4 = 200 mg/l, P6 = 300 mg/l, P8 = 400 mg/l, P10 = 500 mg/l, and U = replication.

From Table 2, there was a difference in the number of live shoot cuttings of Andaliman Simanuk after rootone F 42 DAP treatment, the highest number was obtained in treatment P6 and the lowest was in treatment P0. To ascertain whether rootone F affects the number of live shoot cuttings, it is necessary to perform an Analysis of Variance (ANOVA) test, as shown in Table 3.

Table 3. Analysis of Variance (ANOVA) effect of rootone F on number of live cuttings of andaliman simanuk (*Zanthoxylum acanthopodium* DC) at 42 DAP

SK (Source of Diversity)	df (degree of freedom)	JK (Sum Square)	KT (Middle Square)	Fcount	Ftable	
					5%	1%
Treatment	5	0,797	01594	3,35**	2,37	3,34
Error	54	2,573	0,0476	-	-	-
Total	59	3,370	-	-	-	-

Description: ** = highly significant influence (Fcount > Ftable 5% and 1%)

Table 3 showed that Fcount > Ftable 5% and 1%, meaning that there was a very significant effect of rootone F treatment given at various concentrations. To find out the difference between treatments, it is necessary to carry out a 5% DMRT (Duncan Multiple Range Test) further test as shown in Table 4.

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Table 4. Post Hoc test DMRT 5% effect of rootone F on number of live cuttings of andaliman simanuk (*Zanthoxylum acanthopodium* DC) at 42 DAP

Treatment	Average	Difference Between Treatments						DMRT 5%	Notation
		P0	P2	P4	P6	P8	P10		
P0	0,812	-						-	a
P2	1,g	0,255*	-					0,195	b
P8	1,067	0,255*	0,000	-				0,206	b
P4	1,118	0,306*	0,051	0,051	-			0,213	b
P10	1,118	0,306*	0,051	0,051	0,000	-		0,217	b
P6	1,169	0,357*	0,102	0,102	0,051	0,05	-	0,221	b

Note: * = significant different (value difference between treatments > DMRT value 5%

Age appearing shoots cuttings bud

The age of emergence of shoot cuttings Bud in each rootone F treatment and replication can be seen in Table 5.

Table 5. Age (Days) emergence of life shoot cuttings bud of andaliman simanuk (*Zanthoxylum acanthopodium* DC) with rootone F treatment

Num.	Replication	Treatment					
		P0	P2	P4	P6	P8	P10
1	U1	35	32	27	25	17	17
2	U2	0	32	25	29	17	18
3	U3	0	0	27	29	18	18
4	U4	0	35	25	25	0	0
5	U5	0	0	0	20	21	17
6	U6	0	28	32	25	21	22
7	U7	0	28	32	18	20	20
8	U8	39	30	30	0	0	20
9	U9	0	0	30	24	19	24
10	U10	0	30	0	24	0	0
Total		74	215	228	219	133	156
Average		37,00	30,71	28,50	24,33	19,00	19,50

Table 5 shows that there is a difference in the age of emergence of live shoots of Andaliman Simanuk after rootone F treatment, the lowest/fastest average age was found in P8 treatment which was 19 days and the highest/oldest age in P0 treatment was 37 days. To ascertain whether or not there is an effect of rootone F on the number of live shoot cuttings, it is necessary to carry out the Analysis of Variance (Anova) test as shown in Table 6.

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Table 6. Analysis of Variance (ANOVA) effect of rootone F on Age (Days) emergence of live shoots cuttings bud andaliman simanuk (*Zanthoxylum acanthopodium* DC) 42 DAP

SK (Source of Diversity)	db (degree of freedom)	JK (Sum Square)	KT (Middle Square)	Fcount	Ftable	
					5%	1%
Treatment	5	1112,57	222,514	28,91**	2,45	3,51
Error	35	269,43	7,698	-	-	-
Total	40	1382,00	-	-	-	-

Description: ** = highly significant influence (Fcount > Ftable 5% and 1%)

Table 6 showed that Fcount > Ftable 5% and 1%, meaning that there was a very significant effect of rootone F treatment given at various concentrations. The find out difference between treatments, it is necessary to carry out a 5% DMRT (Duncan Multiple Range Test) further test, as shown in Table 7.

Table 7. DMRT follow-up test 5% effect of rootone F on age (days) emergence of live shoots and cuttings of andaliman simanuk (*Zanthoxylum acanthopodium* DC)

Treatment	Average	Difference Between Treatments						DMRT 5%	Notation
		P8	P10	P6	P4	P2	P0		
P8	19,00	-						-	a
P10	19,50	0,5	-					6,069	a
P6	24,33	5,3	4,8	-				6,384	ab
P4	28,50	9,5*	8,0*	4,2	-			6,552	b
P2	30,71	11,7*	11,2*	6,38	2,21	-		6,720	b
P0	37,00	18,00*	17,50*	12,67*	8,50*	6,29*	-	6,825	c

Note: * = significantly different (value difference between treatments > DMRT value 5%.

Table 7 shows differences between treatments, namely treatment P8 was not significantly different from P10 and P6, but significantly different from treatments P4, P2 and P0. The P10 treatment was not significantly different from the P6 treatment, but significantly different from the P4, P2 and P0 treatments. Treatment P6 was not significantly different from treatments P4 and P2, but significantly different from treatment P0. Treatment P4 was not significantly different from treatment P2 but from treatment P0. The P2 treatment was significantly different from the P0 treatment. From the mean and notation obtained, the best treatment was obtained in treatment P6, because statistically, the notation was the same for treatments P8, P10, P2 and P4.

Number of branch from cuttings bud

The number of branch was counted on each cuttings bud that had grown at 42 DAP. Table 8 shows the number of branch for each treatment and replication.

Table 8 shows the number of branch of cuttings bud ranging from 1 to 2 branch after rootone F treatment, the highest average number of branch was found in the P6 treatment, which was 1.67 branch and the lowest was in the P0 and P10 treatments with 1.0 branch each.

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Table 8. Effect of rootone F on number of branch of andaliman simanuk (*Zanthoxylu acanthopodium* DC) shoots at 42 DAP

Num.	Replication	Treatment					
		P0	**P2**	**P4**	**P6**	**P8**	**P10**
1	U1	1	1	1	2	1	1
2	U2	0	1	2	1	1	1
3	U3	0	0	2	2	1	1
4	U4	0	2	1	1	0	0
5	U5	0	0	0	2	2	2
6	U6	0	2	2	2	1	1
7	U7	0	2	1	1	1	2
8	U8	1	1	2	0	0	1
9	U9	0	0	1	2	1	1
10	U10	0	1	0	2	0	0
Total		2	10	12	15	8	10
Average		1,00	1,43	1,50	1,67	1,14	1,00

Note: P0 = 0 mg/l, P2 = 100 mg/l, P4 = 200 mg/l, P6 = 300 mg/l, P8 = 400 mg/l, P10 = 500 mg/l, U = replication.

To determine the effect of the above data treatment, an analysis of variance was carried out as shown in Table 9.

Table 9. Analysis of Variance (ANOVA) effect of rootone F on number of branch cuttings bud of andaliman simanuk (*Zanthoxylum acanthopodium* DC) Age 42 DAP

SK (Source of Diversity)	db (degree of freedom)	JK (Sum Square)	KT (Middle Square)	Fcount	Ftab	
					5 %	1%
Treatment	5	1.69	0.338	1.46^{ns}	2.45	3.51
Error	35	8.07	0.231	-	-	-
Total	40	9.76	-	-	-	-

Note: ns = non-significant (value Fcount ≤ Ftable 5% and 1%)

Number of leaf cuttings bud

The number of leaf cuttings after rootone F treatment at 42 DAP can be seen in Table 10.

Table 10. Effect of rootone F on umber of leaf cuttings from andaliman simanuk (*Zanthoxylum acanthopodium* DC) at 42 DAP

Num.	Replication	Treatment					
		P0	**P2**	**P4**	**P6**	**P8**	**P10**
1	U1	12 (1)	11 (1)	13 (1)	9 (2)	10 (1)	13 (1)
2	U2	0	14 (1)	8 (2)	16 (1)	10 (1)	11 (1)
3	U3	0	0	9 (2)	9 (2)	13 (1)	15 (1)
4	U4	0	8 (2)	14 (1)	12 (1)	0	0
5	U5	0	0	0	8 (2)	8 (2)	7 (2)
6	U6	0	9 (2)	10 (2)	9 (2)	11 (1)	14 (1)
7	U7	0	6 (2)	12 (1)	13 (1)	14 (1)	7 (2)

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8	U8	9 (1)	13 (1)	7 (1)	0	0	12 (1)
9	U9	0	0	16 (1)	10 (2)	12 (1)	10 (1)
10	U10	0	15 (1)	0	9 (2)	0	0
Total		21 (2)	76 (7)	89 (8)	95 (9)	78 (7)	89 (8)
Average		10,500	10,857	11,125	10,556	11,143	11,125

Description: P0 = 0 mg/l, P2 = 100 mg/l, P4 = 200 mg/l, P6 = 300 mg/l, P8 = 400 mg/l, P10 = 500 mg/l, U = replication, () = number of branch.

Table 10 shows variations in the number of leaves for each treatment, the highest average number of leaves was obtained in treatment P8, which was 11,143 strands, and the lowest was in treatment P0, which was 10,500 strands. Furthermore, to determine the effect of rootone F treatment on the number of leaves can be seen in Table 11.

Tabel 11. Analysis of Variance (ANOVA) effect of rootone F on number of live cuttings of andaliman simanuk (*Zanthoxylum acanthopodium* DC) age 42 DAP

SK (Source of Diversity)	db (degree of freedom)	JK (Total Square)	KT (Middle Square)	Fcount	Ftab	
					5 %	1%
Treatment	5	2.88	0.58	0.07^{ns}	2.45	3.51
Error	35	281.90	8.05	-	-	-
Total	40	284.78	-	-	-	-

Note: ns = non-significant (value Fcount ≤ Ftable 5 % and 1 %)

The results of the analysis of variance in Table 3.10 showed no effect of rootone F on the number of leaves at 42 DAP because the calculated F value ≤ F table 5% and 1%. Furthermore, the parameter number of branches is correlated with the number of leaves, and the value of r = -0.794 (very strong correlation) is obtained. Rootone F significantly affected the number of live shoot cuttings of Andaliman (*Zanthoxylum acanthopodium* DC) at 42 DAP observations. As shown in Figure 1.

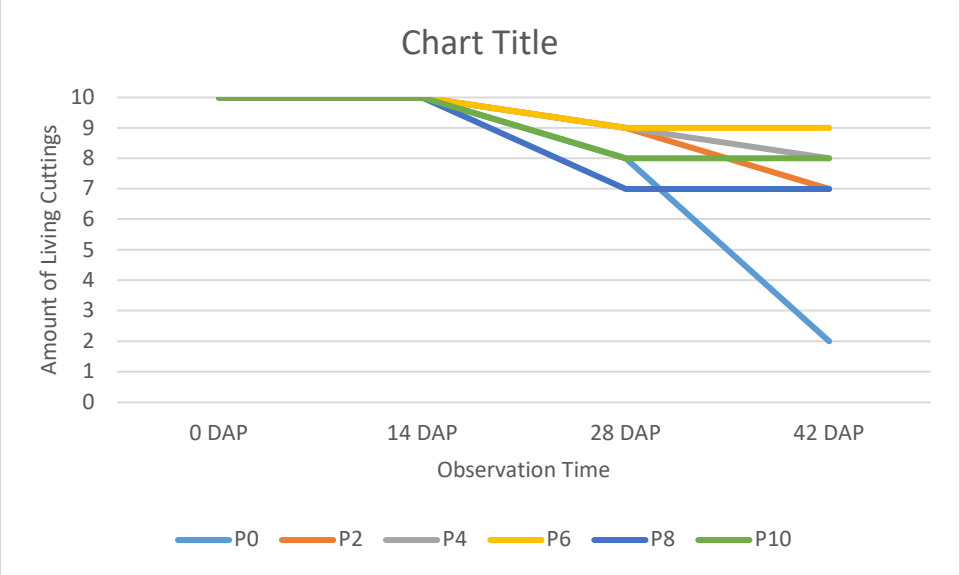


Figure 1. Graph of the number of live shoot cuttings in each treatment for observations 0, 14, 28 and 42 DAP (Days After Planting)

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Figure 1 shows that at observations 0 and 14 DAP all live shoot cuttings, the number of live shoot cuttings began to decrease at 28 DAP observations. The decrease in the number of live shoot cuttings occurred in 42 DAP. Compared with the P0 treatment (0.0 mg/l), there was a significant decrease, namely 2 live cuttings. The difference between the treatment given rootone F and without rootone was visible. According to Kosasih and Rochayat (2000), rootone F is a synthetic ZPT whose active ingredient is a combination of IBA and NAA, which is very effective in stimulating shoots and root growth of cuttings.

Furthermore, all live shoot cuttings were observed at the age of shoot emergence. The data obtained showed a very significant effect of the given rootone F. The different treatments of rootone F concentration gave different results. The longest shoot emergence age was found in the P0 treatment (0.0 mg/l) and the fastest in the P8 concentration treatment (500 mg/l). This means that the higher the concentration of rootone F given, the faster the shoots appear. The best concentration was obtained in treatment P6 (300 mg/l) because it was not significantly different from the other 4 treatments, namely P2, P4, P8, and P10 [8]. stated that the concentration of rootone F affected the length of the cuttings of Begonia tuberosa LMK and the best was at a concentration of 300 mg/l.

The number of branches and the number of leaves from Andaliman Simanuk shoot cuttings did not significantly affect the administration of rootone F at various concentrations. Then we tried to correlate the number of branches and the number of leaves, and it turned out that there was a negative correlation with the value of r = - 0.794 (very strongly correlated).

Conclusion

Rootone F significantly affected the number of live shoot cuttings and the age at which shoots appeared and did not significantly affect the number of shoots and number of leaves. The percentage of live shoot cuttings treated with rootone F was 68.33% at 42 DAP. The best results were obtained in the P6 treatment, namely the administration of rootone F 300 mg/l. There is a strong negative correlation between the number of branches and the number of leaves of Andaliman shoot cuttings, namely r = - 0.794.

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Viability and Activity of *Lactobacillus acidophilus* in Fermented Milk with the Addition of Horn Banana Flour

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Abstract. *Lactobacillus acidophilus is a lactic acid bacterium that is commonly used as a starter in fermented milk. These bacteria are classified in the group of probiotic bacteria because they can provide health benefits to the host when consumed in sufficient quantities. Probiotics can be influenced by the presence of prebiotics, which are compounds that can stimulate the growth and activity of probiotic bacteria. Prebiotics are found in many fruits and vegetables, including bananas. This study aims to determine the viability and activity of probiotic bacteria L. acidophilus in fermented milk with the addition of banana flour. The research design used a completely randomized design with the addition of banana flour at various concentrations. Parameters observed in the study included the viability of L. acidophilus (CFU/ml), total acid (%), pH value, and percentage of decrease in FOS levels in fermented milk. The results of one-way ANOVA showed that there was an effect of the concentration of banana flour on the viability and activity of L. acidophilus in fermented milk. Based on the results of DMRT 5%, the highest viability value was 11.6x108 CFU/ml at the addition of 5% banana flour concentration. The addition of 5% banana flour produced the highest total acid (1.08%), the lowest pH value (4.27), and the highest percentage of FOS reduction (79.53%) based on DMRT 5%. The results of this study provide information about the combination of probiotic bacteria L. acidophilus and banana flour as prebiotic in fermented milk for the development of functional food.*

Keywords: *L. acidophilus*, *horn banana flour, prebiotics, probiotics, fermented milk*

Introduction

The Lactic acid bacteria (LAB) are a group of Gram-positive bacteria, cocci or bacilli cell shape, non-spore-forming, catalase negative, and produce lactic acid as the major product of the carbohydrate fermentation. These bacteria are commonly found in various fermented dairy products, vegetables, meat, fish, legumes, and many other fermented products [1-8].

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One of the LAB species that is often used in the manufacture of fermented milk products is *Lactobacillus acidophilus* [9]. *L. acidophilus* is a probiotic bacterium, originally isolated from the human gastrointestinal tract (10) and is among the most widely used probiotic species in fermented milks. According to WHO (2002), probiotics are live microorganisms which, when administered in adequate amounts, confer a health benefit on the host. The probiotic functionality of *L. acidophilus* includes the alleviation of lactose intolerance, maintenance of the gut microflora balance, immunomodulation via stimulation of host cytokine expression and serum immunoglobulin A (IgA), exclusion of pathogenic microorganisms, and alleviation of cold-like symptoms in children [11].

The use of probiotics in food can experience several obstacles, including the ability to survive, the inability to replicate in the tissues they occupy, as well as nutrient competition in an environment that already contains many other types of bacteria. An approach that can be taken to maintain probiotic activity is by adding prebiotics [12].

Prebiotics are indigestible food compositions such as inulin, fructooligosaccharides (FOS), and galactooligosaccharides (GOS). FOS is naturally found in many fruits and vegetables, for example onion 2.8%, garlic 1%, and wheat 0.7% [13-14]. The distinctive nature of FOS is that it is easily soluble in water and difficult to hydrolyze by enzymes in the digestive tract, making FOS good for consumption because it can reach the large intestine intact [15]. Banana has been currently indicated as a good source of FOS [16] FOS levels in ripe bananas are 4.30% - 6.02% [17]. Horn banana (*Musa paradisiaca* fa. corniculata) is a type of banana that is easy to find and commonly consumed by Indonesian people. Horn banana contains prebiotic fructooligosaccharide of 6.08%. FOS in banana flour not only acts as fiber, but also as a prebiotic which can support the growth of microflora in the digestive tract [18].

The combination of prebiotics and probiotics in fermented milk has better benefits than fermented milk products that only use probiotics [19]. The effect of adding prebiotic compounds is considered quite important because it will affect the activity of probiotic bacteria in the digestive tract, thereby increasing the human body's immunity, and reducing the accumulation of disease-causing pathogens [20].

Methodology

Bacterial Strain and Culture condition

Lactobacillus acidophilus bacterial isolate was obtained from fermented milk products. This isolate was cultivated on DeMan-Rogosa-Sharpe (MRS) agar medium for 24 hours at 37°C. Bacterial inoculum was made in MRS broth. Cell density of inoculum was measured using a spectrophotometer at a wavelength of 600 nm with an absorbance value of 0.44 which is equivalent to 107 CFU/ml.

Preparation of Banana Flour

The horn bananas used in this study were not fully ripe and still have green color. The fruits were washed and boiled for 15 minutes, sliced with a thickness of 0.25-0.75 cm, and were soaked in a solution of sodium metabisulfite with a concentration of 0.3% for 10 minutes. Drying process was carried out using an oven at 75°C for 16 hours. After that, the bananas are mashed with a grinder and sieved using an 80-mesh sieve.

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Measurement of FOS Levels

Fructooligosaccharides level of banana flour was measured using anthrone method. Measurements were made using a UV-Vis Spectrophotometer. At each concentration, 2 ml was taken and put into a test tube, 6 ml anthrone reagent was added and homogenized. The solution was then measured for its OD level at a wavelength of 520 nm. Determination of FOS levels was carried out by substituting the obtained OD values into the FOS standard curve regression equation.

Preparation of fermented milk

Commercial UHT milk was heated to a temperature of 80°C for 15 minutes and put into a 250 ml Erlenmeyer flask. Banana flour was added to the milk in the following concentrations: 1%, 3%, and 5% (v/v). Fermented milk without banana flour (0%) was used as control. As much as 5% of the bacterial inoculum was inoculated into and incubated at 37°C for 24 hours.

Determination of *Lactobacillus acidophilus* Viability

One mililiter of 24-hour fermented milk was diluted in 9 ml of sterile distilled water. Dilutions were carried out serially (10-1-10-9). At the last three levels of dilution, the number of bacteria was calculated using the total plate count method using MRS agar media. Bacterial counts were conducted in triplicate.

Total Acidity Measurement

Measurement of lactic acid levels in fermented milk was carried out by titration. A total of 10 ml of fermented milk sample was added with 2 drops of 1% phenolphthalein indicator and titrated with 0.1 N NaOH until the color changed to pink. The volume of NaOH used was recorded to determine the total acid produced. The formula for calculating total titrated acid is as follows [21]:

$$Acid\ concentration\ = \frac{\mathrm{V1}\ x\ \mathrm{N}\ x\ 90}{\mathrm{V2}\ x\ 1000} x\ 100\%$$

Where V1: Volume of NaOH used for titration (mL), V2: Volume of fermented milk (mL), N: Normality value of NaOH (0.1N) and the number 90 is molecular weight of lactic acid.

Measurement of pH

The pH of sample was measured using an electronic pH meter. Calibration was carried out using phosphate buffer pH 4 and 7, and then rinsed with distilled water. A total of 30 mL of sample was put into a 100 ml beaker and then the pH was measured.

Statistical Analysis

Statistical analysis of the data was performed using the SPSS (Statistical Product and Service Solutions) program version 20.0. Viability value of *L. acidophilus* (CFU/mL), total acid (%), pH value, percentage reduction in FOS levels (%), were subjected to one-way analysis of variance. Duncan's multiple range tests was performed to compare significant differences ($p < 0.05$) in variables between groups.

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Results and discussion

Viability of *Lactobacillus acidophilus*

Lactobacillus acidophilus is widely recognized to have probiotic effects and is one of the most suggested organisms for dietary use. It is frequently added to yoghurt and fermented milk products. The addition of banana flour in this study was conducted to determine the effect of banana flour on the viability of *L. acidophilus*. Based on the results of the one-way ANOVA test, it showed that there was an effect of giving the concentration of banana flour on the viability of *Lactobacillus acidophilus* bacteria with a significance value (P) <0.05. The results of the 5% DMRT test on bacterial viability (Table 1) showed that the viability values of bacteria at concentrations of 0%, 1%, 3% and 5% banana flour were significantly different from the bacterial viability values ranging from 2.59 × 108 CFU/ml – 11 ,6×108 CFU/ml). The highest viability of *Lactobacillus acidophilus* was produced by the addition of 5% concentration of banana horn flour.

Table 1. Results of the DMRT test for bacterial viability of fermented milk with banana flour at various concentrations.

Concentration of horn banana flour	Bacterial number (×10 ^{8} CFU/ml)
0%	2.59 ± 7.25 ^{a}
1%	5,23 ± 4,66^{b}
3%	9,36 ± 3,10^{c}
5%	11,6 ± 7,01^{d}

Note: Number notation that is not followed by the same letter in the same column, shows a significant difference at the level (P>0.05) based on Duncan's multiple range tests (DMRT). Figures shown are mean±SE.

The test results showed that the addition of banana flour at all concentrations increased the viability of *L. acidophilus*. This is possible due to the presence of fructooligosaccharides in banana flour. Fructooligosaccharide is short-chain carbohydrates which resist in-vivo digestion by gastric acid and pancreatic enzymes. Numerous in vitro and in vivo studies have shown that Lactobacillus are stimulated or enriched in the presence of FOS or other oligosaccharides [22]. *L. acidophilus* is a probiotic organism that displays the ability to use prebiotic compounds such as FOS [23]. This explains why the viability of *L. acidophius* increased in fermented milk with the addition of banana flour.

Lactobacillus acidophilus Activity in Fermented Milk

The activity of *L. acidophilus* in fermented milk with the addition of banana flour was observed for several parameters, that is the total acid produced, the pH value, and the FOS levels of the fermented milk. During the fermentation process, *L. acidophilus* will use the available substrate and produce lactic acid as the main product which will cause a decrease in pH value. In addition, the breakdown of fructooligosaccharides showed substrate utilization activity by *L. acidophilus*. Therefore, these three parameters are important to measure to determine the activity of *L. acidophilus* during fermentation.

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Total Acidity and pH value

Table 2. DMRT test results for total acid fermented milk with banana flour in various concentration

Concentration banana horn flour	Total acidity (%)
0%	0.60 ± 0.02 [a]
1%	0.96 ± 0.33 [b]
3%	0.97 ± 0.61 [b]
5%	1.08 ± 0.48[c]

Note: Number notation that is not followed by the same letter in the same column, shows a significant difference at the level (P>0.05) based on Duncan's multiple range tests (DMRT). Figures shown are mean±SE.

Based on the results of the one-way ANOVA test (data not shown), there was an effect of banana flour addition at various concentrations to the total acidity of fermented milk with a significance value (P) < 0.05. The results of the DMRT 5% test for total acid (Table 3), showed that the percentage of total acid at a concentration of 1% was not significantly different from 3% with a total acid value ranging from 0.6% - 1.08%. Fermented milk with the highest total acid was produced by the addition of 5% banana flour concentration. The effect of increasing the concentration of banana flour is directly proportional to the viability of *L. acidophilus* and the percentage of total acid produced. The higher the concentration of banana flour, the viability of *L. acidophilus* increased (Table 2), as well as the percentage of total acid increased (Table 3). This is because the greater the number of *L. acidophilus*, the higher the fermentation activity, as well as the total amount of acid produced. The total acidity of normal fermented milk products is within the range of 0.7 ~ 1.2 % [24]. In this study the total acidity obtained in fermented milk with banana flour was ranging from 0.6 to 1.08% (Table 3). Therefore, the results in this study are categorized as having met the predetermined standards.

Relationship between total acidity and pH during lactic acid fermentation were important. The pH value indicates the degree of acidity of the fermented milk where the pH in the fermented milk is closely related to the acid content produced. the pH value of dairy products is obtained from the activity of lactic acid bacteria which produce acid in fermented milk [25]. The pH value can be used to determine the activity of *L. acidophilus* in milk fermentation. The lower the pH value, the higher the total acidity produced [26]. The increase in lactic acid levels in fermented milk is inversely proportional to the decrease in pH, meaning that the greater the total amount of lactic acid, the resulting pH decreases. This can happen because the lower the degree of acid dissociation of a material in solution, the greater the tendency to release protons (H+ ions) into the environment, so that the pH in fermented milk experiences a decrease in the degree of dissociation [27-28].

Table 3. DMRT test results for pH value with addition of banana horn flour in various concentrations

Concentration banana horn flour	pH value
0%	5.28 ± 0.03 [a]
1%	4.66 ± 0.64 [b]
3%	4.42 ± 0.34 [c]
5%	4.27 ± 0.23 [d]

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Fructooligosaccharide (FOS) concentration

Prebiotics are a group of non-digestible food ingredients but can be used by the microbiota in the digestive tract, especially by probiotic bacteria. Fructooligosaccharides (FOS) and galactooligosaccharides (GOS) are the two important groups of prebiotics with beneficial effects on human health. In this study horn banana flour became a source of prebiotic FOS in milk.

Table 4. The results of the DMRT test for the percentage decrease in FOS levels in fermented milk by adding horn banana flour at various concentrations

Horn Banana Flour	FOS level (mg/g)		
	Before fermentation	After 24 hours fermentation	Decrease in FOS concentration (%)
1%	0.3	0.25 ± 0.008 [b]	16.09 ± 3.03 [b]
3%	0.6	0.32 ± 0.008 [c]	45.35 ± 1.36 [c]
5%	1.8	0.36 ± 0.005 [d]	79.53 ± 0.26 [d]

Note: Number notation that is not followed by the same letter in the same column, shows a significant difference at the level (P>0.05) based on Duncan's multiple range tests (DMRT). Figures shown are mean±SE.

Table 4 shows a decrease in FOS concentrations before and after fermentation. The concentration of FOS decreased in the range of 16.09% - 79.53% depending on the concentration of banana flour given. This is because FOS which is an oligosaccharide will be broken down into glucose and will undergo fermentation. In the metabolic process, FOS will enter the bacterial cell of *L. acidophilus* and will be converted into glucose 1-phosphate which will then pass through the glycolysis pathway to become pyruvic acid and produce lactic acid [29]. The presence of a multiple-sugar metabolism (msm) operon transport system will also mediate the uptake of FOS into cells which will later be hydrolyzed intracellularly [22].

Conclusion

There is an effect of the addition of banana flour in various concentrations on the activity of *Lactobacillus acidophilus* bacteria in fermented milk. The concentration of 5% plantain flour in fermented milk resulted in the highest *L. acidophilus* viability value of 11.6x108 CFU/ml. The addition of 5% plantain flour also produced the highest total acid (1.08%), the lowest pH value (4.27), and the highest percentage of FOS reduction (79.53%). An understanding of the increased viability and activity of probiotic bacteria *L. acidophilus* due to the presence of prebiotic FOS in plantain flour can be the basis for further development of synbiotic milk products.

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Implications of project based learning on protist materials toward students' independence learning and learning outcomes

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Abstract. *This study aims to determine the effect of Project Based Learning on learning independence and student learning outcomes in protist material. The type of research used is Quasi Experiment with the Nonequivalent Control Group Design research design. The sample used consisted of 2 classes totaling 70 students. Data collection techniques were used to pretest and posttest questions and self-learning questionnaires. The average score of learning independence in the experimental class was 76.1 and 70.6 in the control class. In the experimental class, the average pretest score was 33.37, and the average posttest score was 85.03, while in the control class, the average pretest score was 33.26, and the average posttest score was 78.74. The increase in learning outcomes is shown by the n-gain value of 0.78 in the experimental class and 0.69 in the control class. Based on the test of differences in the two sample classes, the sig. is 0.000 < α 0.05, so the students' independence and learning outcomes in both classes are significantly different.*

Keywords: project based learning, students' independence, learning outcomes

Introduction

As an instructional design that designs interaction patterns and student learning experiences, learning models play an important role in student learning success [1]. The right learning model can direct learning activities to help students in such a way that learning objectives are achieved. The use of certain learning models needs to be adjusted to the goals to be achieved, with the characteristics of learning materials as well as the characteristics and needs of students [2].

With the development of technology that can be utilized in learning, the selection of learning models also needs to consider the development of student learning independence [3-4]. One of the factors that can affect learning outcomes is learning independence. Learning independence is needed to maximize learning processes and activities. Students who have independent learning will be encouraged to develop their learning processes not only while at school but also carried out independently by using the learning resources and facilities they have [5].

One learning model that is thought to be able to encourage the development of student learning independence is project-based learning. Project-based learning carries the philosophy of constructivism where the activity design involves students in complex real-world problems and produces products or presentations to audiences that enable students to acquire the expected knowledge and skills [6-8]. Through project activities, students will be accustomed to analyzing,

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developing ideas, and not relying on the teacher as the only source of knowledge. So, this research was conducted to test whether the application of project-based learning can support the development of independent learning.

Methodology

This research was conducted at SMA N 1 Besitang which is in Pekan Besitang Village, Besitang District, Langkat Regency, North Sumatra in January-February 2022. The samples taken were two classes namely X1 with 35 students who were taught using the Project Based Learning Model and class X2 as many as 35 students in a class taught using the traditional instruction (TI). The design used in this study is the Nonequivalent Control Group Design. In this study, two groups were used, namely the experimental group and the control group.

Initial tests (pre-test) are given before learning, both for Project Based Learning classes and traditional learning classes. After the implementation of teaching is complete, a final test (post-test) is held. The instrument used in this study was a multiple-choice test of learning outcomes. The test is a cognitive test consisting of 25 questions with five answer choices. Analysis of learning outcomes is done by calculating the mean and standard deviation. The prerequisite test is carried out using the normality test and homogeneity test. For the normality test, the Lillefors test was used, and the homogeneity test used the F test. In testing the hypothesis, analysis of variance and t-test were used to see differences in the average value of the sample classes. After learning and giving cognitive tests are completed, students are then given a learning independence questionnaire with 30 statement items to measure the level of student learning independence.

Results and discussion

Implications of project based learning on learning outcomes

The implementation of protist learning was carried out three times, where each face-to-face meeting was held for 90 minutes. Pre-test data in the experimental class and control class have relatively the same average value. After learning by applying each strategy, it was obtained that the average post-test for the experimental class was higher than the average for the control class. See table 1.

Table 1. Comparison of students' knowledge before and after learning

	Project-based		**Traditional instruction**	
	Pre-test	**Post-test**	**Pre-test**	**Post-test**
Student knowledge	33,37	85,03	33,26	78,74

In project-based class, students and their groups discuss material with reference to the worksheets prepared by the teacher. They then presented the results of the discussion and held a question-and-answer session. Students work on project assignments to develop animal-like protist props and present them in front of the class. Through project-based activities, students are given hands-on opportunities to work with concepts from course material, discuss approaches in peer groups, and demonstrate their work [9]. Compared to traditional instruction, project-based learning is more student-centered, with characteristics that focus on important concepts, apply

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inquiry processes, realistic projects, relate to real problems, constructive investigations, and produce products [10-11].

Project Based Learning can make students manage their learning, be directly involved with the objects being studied, design processes to be carried out and find solutions to problems and be able to present learning and products that have been worked on. In traditional instruction, students tend to receive direct information from the teacher and discuss the information that is already known by the students. Traditional instruction can cause students to be more passive and not have the opportunity to discover the concepts being taught on their own.

Project-based learning is a student-centred constructivist approach, when learning students are actively involved, and can find and produce something both independently and in groups, then students can develop academic and social-psychological skills [12]. Conventional learning emphasizes content recitation, without giving sufficient time for students to reflect on the material presented, relate it to previous knowledge or apply it to real-life situations, and passive learning occurs [13].

To find out how much the increase in student learning outcomes after being given treatment, N-gain analysis was carried out. The results of the N-Gain test can be seen in table 2. Learning outcomes in the project class have increased in the high category. While in the control class, the increase occurred in the medium category. The results of the calculation of the independent sample t-test on the learning outcomes of the two classes, obtained a sig (2-tailed) value of $0.000 < \alpha$ (0.05).

Table 2. Improvement of student learning outcomes

Class	Pre-test	Post-test	N-Gain	Criteria
Project	33,37	85,03	0,78	High
TI	33,26	78,74	0,69	Moderate

The impact on students' learning independence

Measurement of student learning independence is carried out using a self-assessment technique at the end of learning. Based on Table 3, shows that the average learning independence of the experimental class is greater than that of the control class. This difference is thought to be an implication of student activity in the project class which is encouraged to discuss and develop knowledge independently and design problem-solving designs through project assignments. The results of independent sample t-test calculations on learning independence data from both classes, obtained a sig (2-tailed) value of $0.000 < \alpha$ (0.05).

Table 3. Comparison of students' learning independence

Class	n	Highest score	Average score
Project	35	83,3	76,1
TI	35	76.7	70,6

By making protist teaching aids, students took the initiative to use used materials found in the surrounding environment. They can develop a three-dimensional model based on the observations and knowledge they have acquired through discussion and literature review. Students design project activities and find solutions to problems so that students are more independent and responsible for the project assignments they are working on.

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Aspects of independent learning associated with the Project Based Learning model include (1) Students can prepare learning materials without being asked by the teacher, (2) Students solve problems with project ideas, (3) Students create projects without teacher direction, (4) Students interact active in discussions, (5) Students present group projects independently. Measurement will be achieved through the indicators of learning independence used in this study, namely active learning, independence from others, having self-confidence, having a sense of responsibility, behaving on their own initiative, respecting time, and exercising self-control.

Based on the results of the analysis of student learning independence above, student learning independence in the project class belongs to the "very high" category. According to [14] in the Project Based learning process, students experience themselves and are directly involved with the objects they are studying. Students learn based on their own experiences and interests as well as the material in integrated subjects. Learning with Project Based Learning can influence student learning independence, helping students to develop thinking skills, design skills, project work skills, as well as motivating learning and demanding independent learning for students and being responsible for the learning they do.

Learners are required to have good learning independence as the main modality in constructivist learning. Project Based Learning focuses on the main concepts and principles of a discipline by involving students in problem solving activities and meaningful assignments, providing opportunities for students to work independently to construct their own learning, and the culmination is to produce valuable and realistic student work [15].

Conclusion

Based on the above data and analysis, it can be concluded that the application of project-based learning has a positive impact on student learning outcomes and independence. These results add to the references and recommendations in the application of project-based learning as an alternative teaching and learning strategy in biology. However, it is necessary to conduct further studies on what kind of project learning interaction design is most appropriate for students with different levels of independence.

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The ability of biology students' science process skills on the material of protist

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Abstract. *This study aims to describe the students' science process skills and the implementation of these skills in learning protozoa. The research was conducted at the Biology Education Study Program, State University of Medan. This type of research is a descriptive combination that uses tests and questionnaires as research instruments. The sample used in this study was 44 students. Sample selection was done by random sampling. The results showed that the ability of science process skills in protozoal learning was in the "good" category by 70%, which consisted of 90.34% interpretation ability and 81.84% very good experimentation. good student skills in classifying 76.61%, observing 64.20%, asking 62.50%, and using tools and materials at 61.93%. Meanwhile, 56.81% of students' abilities to communicate and predict (41.47%) are still in the sufficient category.*

Keywords: science process skills, interpretation, observing, protozoa

Introduction

Biology is also a learning discipline in that all aspects of learning are based on scientific processes, such as practicum activities, observing, analyzing, experimenting, and others. One of the scientific processes is scientific process skill [1]. Science process skills should be taught to student teacher candidates, including prospective Biology teachers, so that they have experience and resources for implementing learning that develops student science process skills. Science skills are skills that can be used to understand any phenomena that occur. These skills are needed to acquire, develop, and apply the concepts, principles, and laws that exist in science [2]. Learning biology on protozoan material can be analyzed because, this material has very diverse

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classifications and species, making it difficult to identify both its characteristics and morphology, as well as its life in water, making it difficult to identify its body structure [3].

In studying protozoa, students cannot be separated from aspects of science process skills, which consist of observing skills, classifying, using material tools such as a microscope to observe microscopic protozoa, and conducting experiments such as practicum activities to find out and better understand and recognize the types of protozoa. types of protozoa. Learning protozoa is very closely related to the component aspects of science process skills because it is based on practicum-based learning.

Based on a preliminary study that has been conducted on Biology Education students at the State University of Medan, it was concluded that students had heard of the term "science process skills" and could find out what aspects of science process skills exist, and based on this preliminary study, students who had heard of and knew about science process skills gave a statement that they had applied the components of science process skills in learning protozoa.

Students assume that the component aspects of science process skills that are the most difficult to implement are interpretation with a percentage of 45% and prediction with a percentage of 30%. This happens because students are not accustomed to applying science process skills, especially in the aspects of interpretation and prediction. "Analysis of science process skills in general biology courses," that the difficult aspects of science process skills were predicting, hypothesizing, planning experiments and research, using tools and materials, applying concepts, and communicating [1].

This is because the aspect of science process skills that is closely related to experimental or practicum activities is very important, and students who take this Low-Level Organism Taxonomy course have never done practicum, so the science process itself, especially in terms of designing and carrying out experiments, is very lacking.

Students also think that science process skills really need to be applied to learning protozoan material in order to improve the quality of the learning process and ensure that the material can be understood properly. Based on the existing problems, it is necessary to conduct research with the goal of determining the ability of science process skills of biology education class 2021-2022 students in learning protozoa.

Methodology

This is a qualitative descriptive study conducted at the State University of Medan. The research sample consisted of 70 students class of 2021-2022 Biology Education students who were selected by random sampling. The data collection technique used an instrument test in the form of an essay test based on HOTs. The test is based on aspects of science process skills, namely the ability to observe, classify, interpret, predict, communicate, ask questions, plan experiments, use material tools, and apply concepts. The data obtained were then converted to the table of criteria for science process skills in Table 1.

Table 1. Category of student science process skills

Criteria	Scale
Very low	<20%
Low	21% - 40%
Enough	41% - 60%
Good	61% - 80%
Very good	81% - 100%

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Results and discussions

Results

The data on the student's science process skills test on this protozoan material was obtained from the results of an essay test consisting of five items arranged according to aspects and indicators of science process skills. The data recapitulation of students' science process skills test results for each aspect can be seen in table 2.

Table 2. Science process skills aspects

No	Science Process Skills Aspects	Persentase	Category
1	Planning an experiment	81,84%	Very good
2	Using tools/materials	61,93%	Good
3	Observe	64,2%	Good
4	Classification	76,61%	Good
5	Asking question	62,5%	Good
6	Communicating	56,81%	Enough
7	Interpretation	90,34%	Very good
8	Prediction	41,47%	Enough
Range		**70.00%**	**Good**

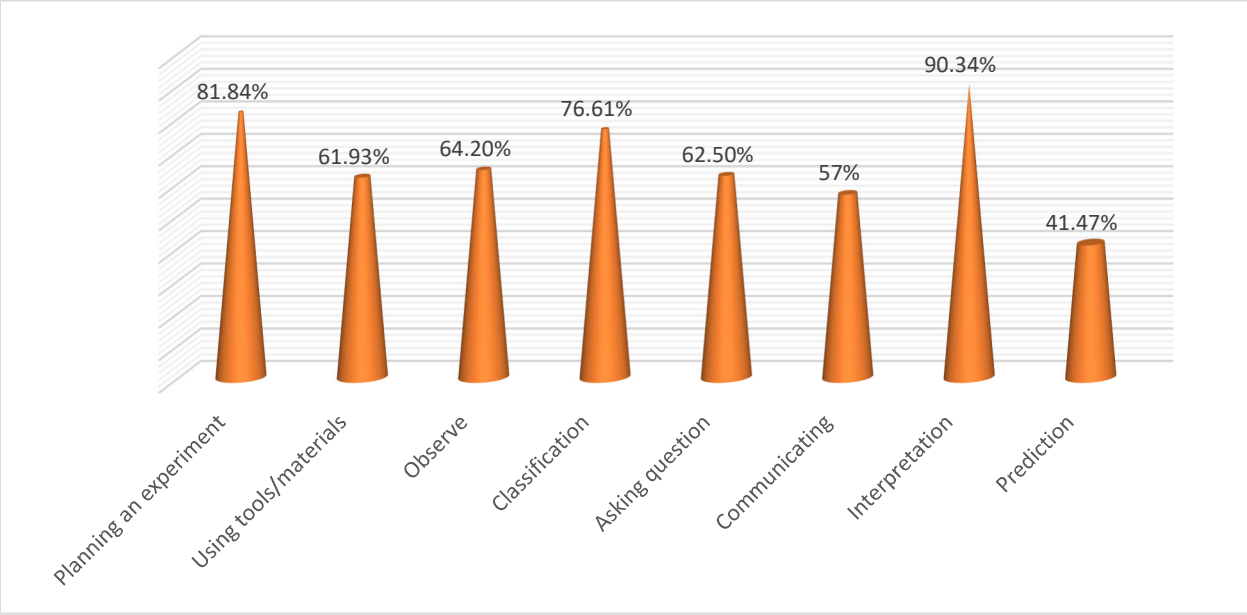


Figure 1. Diagram of percentage of student science process skills

Discussion

Aspects of planning experiments

The activity of planning an experiment is closely related to students' knowledge of what tools and materials will be used in the experiment that is to be planned and how the work procedures

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are carried out in carrying out the experiment. The overall results obtained by students can be said to demonstrate their ability to plan experiments well, where they are able to determine the material tools before carrying out the activity of observing water samples to find the types of protozoa contained in them and designing work procedures in planning the experiment. Continuous and experimental practicums can be used to improve the quality of experimental design skills [4]. Researchers must make plans to make observations so that unimportant things are not overlooked or so that unnecessary repetition does not occur [5]. Planning involves determining the problem or object to be studied, determining research objectives, determining the scope of research, determining tools and materials, and determining research methods.

Aspects of tool and material use

One aspect of science process skills related to essential laboratory skills is the ability to use tools and materials. The skills in using tools and materials can be categorized into several categories, including: (1) selecting, installing, operating, opening, cleaning, and returning equipment; (2) matching equipment; (3) reading the measuring instrument carefully; (4) handling, preparing, and being aware of the dangers of a material; (5) detecting, calibrating, and correcting errors in setting up equipment; and (6) drawing equipment accurately [6].

To be able to have the skills to use tools and materials, students must use the tools and materials directly in order to gain direct experience [7]. In addition, students must know why and how to use tools and materials. However, in this assessment, the indicators assessed from the aspect of using tools and materials are the reasons for using these tools and materials.

Based on the test, students are given questions where the question is a follow-up question from planning an experiment. After determining the tools and materials in the question, students are asked to write down the reasons for using the tools and materials used. According to the questionnaire, students were asked whether they knew how to use tools or materials for protozoa observation.

The test results show that students are good at giving reasons for using tools and materials. Students write that stationery is used to write observations, water bottles are used for containers of water samples to be observed, cover glass is used to cover water samples, object glass is used for placing a water sample so that it can be observed under a microscope, and a microscope is used to observe the protozoa contained in the water sample. Then, for the material used, the water sample serves as an object to be observed in the observation of protozoa.

Aspect of serving

The ability to observe is a fundamental component of scientific process skills.Observing includes the ability to use all the senses you have and collect or use relevant facts [8] . Practicum is one of the best vehicles for developing observation skills. In the implementation of the practicum, students are actually faced with real objects that require the use of all senses in order to fulfill their observing skills [9].

In the science process skills test, students are asked to pay attention to a video, and then after watching the video, they are asked to answer questions to explain the morphological characteristics of the two organisms in the video so that they are grouped into the same superphylum, which is part of the protozoa.

The results obtained by students can be said to be able to "observe," which in this observing activity is closely related to the five senses and prior knowledge to analyze an object being observed and cannot be separated from relevant references. "Observing" is our response to various objects and natural events using the five senses [7]. Observing is the most basic skill in

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the process, and gaining knowledge is the most important thing for developing other process skills. The aspect of observing is the most basic that a person must have.

Aspect of classification

The ability to classify is closely related to the ability to observe, because before classifying or grouping an object, you must first carry out observing activities so that the object can be properly analyzed by observing morphological characteristics, habitat, reproduction, etc. before the organisms are grouped by taxon. Based on the research results, students already have good skills in classification, where they are able to look for similarities and differences between amoeba and paramecium, contrast the characteristics of the two organisms, and then look for the basis for grouping the two organisms.

The grouping or classification of objects is based on observations, and when classifying, first observe the characteristics to be classified [10]. The classification is a systematic method used to classify something based on certain conditions [1]. The classification process includes several activities, such as looking for similarities, looking for differences, contrasting features, comparing, and finding the basis for grouping. Based on the assessment, students are said to be very capable in carrying out classification activities.

Aspects of asking questions

Based on the test answers, students have been able to write answers to the aspect of asking questions properly and in accordance with the discourse. Some examples of student answers are: what is the role of protozoa in ruminant digestion?, how is the process of digestion of fiber in the rumen?, and why protozoa can be the highest population found in the rumen.

The results obtained by students are said to be able to answer questions where students already have a curiosity to ask what, why, and how. The clarity of the questions asked by students also indicated the degree of their curiosity about what they wanted to know and what they had understood [11]. Students who actively ask questions will get answers as a solution to overcoming curiosity and things that are not understood.

Aspect of communication

The skill of communicating the results of observations (communication skills) is a basic aspect that is also related to social skills [12]. The ability to communicate is very necessary because humans interact with other humans through communication, either orally, in writing, in pictures, or through impressions. One aspect of science process skills is communication, which is demonstrated by students' ability to present their knowledge in the form of words and writing [5]).

Based on the test results to explain the experimental results, the students' abilities are quite sufficient. This is based on the fact that many students only answered three or two questions, or even one question that students were able to answer, but there were some students who were able to answer all four questions related to explaining the experimental results. the

For the question of making graphs based on research results, most of the students are less precise in making the graph. The graphs made by students do not show the status (cured, dead, or unknown) of humans who suffer from trypanosomiasis every year. Based on the test results, the overall result is that students are quite capable of communicating. This can happen because students are less able to communicate. reading graphs, tables, or diagrams from experimental results, including communicating in learning activities [13]

Communication skills that are lacking and very fatal have an impact on everyday life and especially in the world of lectures. In the world of lectures students will always be required to be able to communicate the results of discussions, observations, write scientific papers, write

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practicum reports, presentations, make tables, etc. Communication in science is the presentation or communication of scientific data or facts by the communicator to the communicant [14]. If students do not have good communication skills, it will produce students who are passive and uncommunicative and not good at writing scientific papers.

Aspects of interpretation

In terms of interpretation skills, it is the ability of students to record observations separately, connect observations, and find regular patterns in order to draw conclusions from the observations they receive. Students can practice concluding skills by observing the clues and evidence that lead to the object to be concluded [15]. Interpretation skills are the skills needed to draw conclusions based on existing facts [16].

The interpretation aspect presented in the test is in the form of a discourse about malaria, but the discourse only explains the symptoms of malaria and its carrier vectors, and students are asked to draw temporary conclusions about what type of disease it is, while in the questionnaire the interpretation aspect is presented in the form of questions about whether students are able to make tentative conclusions.

Based on the test, it was found that students were very able to carry out interpretation activities. It was also seen that students were able to draw temporary conclusions by connecting the results of their observations. In the interpretation aspect, students must have good observation skills first. With good observing skills, the skills in interpretation will also be good [1]. This is in accordance with the results of the study, which are based on the results of the research aspect of observing, which is included in the good category, and have an effect on the results of the interpretation assessment, which is in the very good category.

Aspects of prediction

The indicator assessed on the test in this study is to express what has happened in circumstances that have not yet occurred. Based on the test, students were asked what might happen if a malaria patient experienced bleeding, such as vomiting blood, while in the questionnaire, students were given negative questions in the form of whether they were unable to predict something that might happen based on their own estimates.

On the results of the test answers, students were less able to answer the question. The students answered that the thing that would happen to the malaria sufferer was the destruction of red blood cells, causing bleeding. The student's answer was less specific. It should be possible that if the patient has vomited blood, there has been a decrease in platelets (thrombocytopenia), which causes bleeding. This process is triggered by various factors, including genetics, infection, malignancy, and others. This spontaneous bleeding will threaten the patient's life.

Students are quite capable of making predictions. This happens because the predictive aspect is very closely related to experimental or practicum activities; with practicum activities, students will indirectly use all their five senses and practice their skills.

Conclusion

The ability of students in biology education in the class of 2021-2022 at Medan State University to learn science process skills in learning protozoa is in the good category, with a percentage of 70%. However, there are several aspects that must be considered, namely the ability of students to communicate and predict, which is still included in the "sufficient" category. This is because students are not used to being required to be able to predict the possibilities that may occur based

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on the given case, as well as the limitations of their numerical literacy, so that they experience problems when communicating data in the form of graphics.

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Literacy ability of biology education students through the implementation of biology teaching and learning strategy textbooks

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Abstract. *This study aims to improve the literacy skills of prospective biology teacher students related to biology teaching and learning strategies. This development research used 62 biology education students as research subjects, who were determined by purposive random sampling technique. Data was collected using a Likert scale questionnaire, literacy test, and analyzed using percentage techniques, as well as t-test at a significance level of 0.05. The results showed that students' understanding of learning and learning theories was very good (90.28%), approaches, strategies, methods and learning models were in good category (86.72%), biology learning structures were in good category (87.49%)), the components of interaction in teaching are very good category (91.35%). The literacy ability of students who were taught using textbooks on biology teaching and learning strategies resulted in higher development than those who did not have textbooks, with the calculation of* t_o *(6.74) >*t_t *(2.00), at df = 60, p = 0.05.*

Keywords: literacy, textbooks, teaching and learning strategies, biology education

Introduction

Literacy skills have recently become important to discuss because their implementation is very urgent in the world of education in Indonesia [1]. Many studies in the world provide information about literacy and this is a very essential skill in the information age [2]. Information and communication technology (ICT) literacy represents an essential skill for adolescents to efficiently participate in a modern society [3]. Student feedback literacy denotes the understandings, capacities and dispositions needed to make sense of information and use it to enhance work or learning strategies [4].

Feedback processes are difficult to manage, and the accumulated frustrations of teachers and students inhibit the learning potential of feedback [5]. Student literacy skills should always be known from time to time [6]. Thus, improvement efforts can be made by providing appropriate learning resources and in accordance with student development [7]. Literacy skills can be increased by using adequate textbooks [8].

Literacy skills are related to student learning activities [9]. Student activities in learning are actively seeking and finding subject matter both on campus and at home [10]. Including libraries and various learning resources which play an important role in increasing literacy skills in the world of education [11]. Literacy skills are also related to the curriculum and learning

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programs [12]. It can even be improved through the influence of interactions with lecturers in the learning process and media utilization [13].

Investigation of students' literacy skills related to various learning topics can be seen from their reading skills [14]. Also the use of the internet, as reported from the results of research on adolescents, that digital literacy skills are supported by the amount of time students spend studying using the internet [15]. In addition, literacy skills can be seen from the willingness of students and opportunities to use their time through printed and digital textbooks.

Textbooks as a source of student learning need innovation and creation in line with the increasingly rapid development of information technology. Including textbooks used by prospective biology teacher students in the Biology Teaching and Learning Strategy course. The development of literacy-based textbooks is very important to do in encouraging students to have skills, awareness and character formation. This is in line with the opinion of Rusilowati[16] who said that the development of textbooks can improve students' literacy skills and at the same time shape student character to be motivated and diligent in learning.

Methodology

This research and development uses the ADDIE model through the stages of analysis, design, development, implementation and evaluation. In this article, data is presented relating to the implementation results. Implementation of Biology Teaching and Learning Strategy textbooks in 2 classes. Class A (PSPB 21B) students are presented with textbooks on Biology Teaching and Learning Strategies as a result of developmental research, while class B (PSPB 21D) uses literature that is not derived from development results. The number of students in class A (PSPB 21B) is 30 people, while the number of students in class B (PSPB D) is 32 people. The research sample was determined using a purposive random sampling technique, on the grounds that the student was attending a Biology Teaching and Learning Strategy course.

The analysis stage research was carried out for 1 month, the design stage for 2 months, the development stage for 2 months, the implementation stage for 2 months, and the evaluation stage for 1 month. So the research time is 8 months, from March to November 2022. In the implementation stage, the Biology Teaching and Learning Strategies textbook uses the same lecturer for both classes, and also uses the same learning model, namely the project-based learning model. Students compile work projects whose sources can be obtained from various sources, and for class A (PSPB 21B) they are required to use a biology Teaching and Learning Strategies textbook as a result of research development.

At the implementation stage, there are four topics of lecture material presented, namely: (1) Learning and learning theories; (2) Approaches, strategies, methods and learning models; (3) Biology learning structure; and (4) Components of interaction in teaching. After implementation, a test of 8 questions was carried out in the form of narrative questions to measure students' literacy skills. Questionnaires were also distributed to students to obtain data related to student attitudes in the form of student responses about the Biology Teaching and Learning Strategies textbook. The data were analyzed using the percentage technique and given meaning to the tendency of the respondents.

Result

Based on the results of tests carried out on 62 respondents, students' literacy skills were obtained on the four subject matter topics as shown in Table 1 below.

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Table 1. Student literacy ability test results

No	Subject matter	Mean Class A	Mean Class B
1	Learning theories	90.28	84.24
2	Approaches, strategies, methods, and learning models	86.72	72.36
3	Biology learning structure	87.49	80.61
4	Components of interaction in teaching	91.35	82.88
5	Material totals	88.92	80.02

Based on the results of the two-party t test at a significance level of 5%, it is obtained as shown in Table 2 below.

Table 2. Gain score t test results

Independent Sample Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Gain Score	Equal variances assumed	.647	.234	6.742	60	.000	13.931	4.165	7.416	16.72
	Equal variances not assumed			6.742	60	.000	13.852	4.165	7.328	15.64

Data from questionnaire processing regarding student attitudes related to the implementation of the Biology Teaching and Learning Strategy textbook were obtained as shown in Table 3 below.

Table 3. Student attitudes

No	Attitude Component	Class A		Class B	
		Score	Category	Score	Category
1	Curiosity	3.88	Very Good	3.21	Good
2	Have achievement motivation	3.92	Very Good	3.15	Good
3	Enthusiastic in learning	3.74	Very Good	3.33	Good
4	Solve the problem	3.65	Very Good	3.02	Good
5	Critical attitude	3.78	Very Good	3.06	Good

Based on data regarding the analysis of the types of literacy possessed by biology education students as prospective biology teachers, it is shown in Table 4 below.

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Table 4. Ability types of biology education students' literacy

No	Literacy Component	Class A		Class B	
		Score	Category	Score	Category
1	Read and write Literacy	87.29	Very Good	80.21	Good
2	Numeracy literacy	85.25	Very Good	81.93	Good
3	Science literacy	86.62	Very Good	82.26	Good
4	Digital literacy	86.24	Very Good	83.83	Good
5	Cultural literacy	88.16	Very Good	81.95	Good
6	Financial literacy	80.36	Good	80.14	Good

Discussions

The literacy ability of students in classes that are taught by implementing the Biology Teaching and Learning Strategy textbook shows a higher level compared to classes that use various learning resources not from textbooks that have been developed. This shows that the textbooks that have been developed are suitable for use and can improve students' literacy skills. The implementation of this textbook turned out to be able to help students improve their ability to process information, develop understanding and self-potential. This is in line with research from Septi[17] which says that growing interest in reading increases literacy skills through activities responding to enrichment books, and which increases literacy skills. Likewise the Biology Teaching and Learning Strategies textbook can foster students' interest in reading by 7.08%.

Biology education students through textbooks that have been developed are able to solve problems and communicate various tables and graphs. This is in line with the results of Siregar's research [18] which states that numeracy skills are supported by students' willingness in the learning process. This is also in line with the research results of Wahyuni, et al [19] which state that students' literacy skills are closely related to reading abilities and the process of mentoring lecturers.

The ability to understand issues and explain scientific phenomena of biology education students is included in the very good category. This shows that students' literacy skills can be improved by using the Biology Teaching and Learning Strategies textbook that has been implemented. This is in line with the results of Liu's research [20] which states that science education reform in parts of the world leads to an increase in scientific literacy skills in students.

The ability to use digital media and communication tools is a very important part to be mastered by prospective biology teacher students. The results of this study indicate that students' digital literacy skills taught with the Biology Teaching and Learning Strategies textbook can be improved. This is in line with the results of Setyansah's research [21] which states that having knowledge of the web for someone will increase digital literacy.

The ability to understand national identity as cultural literacy really needs to be possessed by students. The results of this study related to cultural literacy show that biology education students are included in the good category. As a biology teacher candidate, it is very important to have a national identity and to be proud to be Indonesian. Research related to cultural literacy as conducted by Sumanti[22] found that the implementation of cultural literacy can be carried out in schools through a reading culture, so that students have positive habits in exploring knowledge. This is also in line with the results of Sari's research [23] which states that the school literacy movement is a culture that needs to be continuously developed.

The ability to understand concepts and risks in a financial context is also very much needed by students. According to the Ministry of Education and Culture, Indonesia, financial

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literacy education is needed to educate people to be aware and understand how to manage finances wisely. Students although learning about Biology Teaching and Learning Strategies need to also have entrepreneurial abilities. This is in line with the opinion of Burchi, et al [24] that entrepreneurial skills can foster financial literacy skills for students. Widyastuti, et al added that financial literacy skills are closely related to educational literacy skills.

Based on the results of the research, the ability of students in biology education showed that they had mastered learning theories very well, as well as mastered the structure of learning biology which was also very good. The results of this study indicate that students' literacy skills increase with the implementation of the Biology Teaching and Learning Strategies textbook. This is in line with the results of research by Rusilowati, et al [25] which said that development products in the form of textbooks can improve student literacy skills. Likewise the results of research by Astuti, et al [26] which stated that students who were active in studying textbooks would be more effective in improving their literacy skills.

Conclusion

The implementation of the Biology Teaching and Learning Strategy textbook using the ADDIE model shows that it can improve the literacy skills of biology education students. This can be seen from increasing the ability to master learning theories, approaches, strategies, methods, and learning models, structure of learning biology, and components of interaction in teaching. Better literacy skills are owned by biology education students who are future biology teacher candidates.

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In vitro pineapple (*Ananas comosus* L.) growth induction from Sipahutar, North Sumatra with addition of coconut water and plant growth regulator

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Abstract. *Sipahutar pineapple is a horticultural product with prospects and potential to develop. Development of Sipahutar pineapple is very important to do. The problem of Sipahutar pineapple cultivation is there are no producers that can supply better quality pineapple buds in large quantities and best quality. On the other hand, contribution of Sipahutar's fresh pineapple in international is lack, so we need a solution that can make solution of these problems. This study aims to determine influenced of 1). Coconut water, 2) Kinetin, 3) The interaction of coconut water and kinetin to in vitro Pineapple (Ananas comosus l.) growth induction. The optimal concentration of coconut water and kinetin for pineapple growth. This study is an experiment using a factorial, completely randomized design (CRD). The first factor is the concentration of Coconut Water (0, 10, 20, and 30) %. The second factor is the concentration of Kinetin (0, 2, and 4) ppm. The results showed: 1) Coconut water affected the increase in the number of roots, 2) Kinetin involved the rise in the number of shoots and the number of seeds, 3) The interaction of coconut water and kinetin affected the number of seeds. The best media combination for increasing the number of shoots was coconut water treatment with 0%, kinetin 4 ppm. The best media combination for increasing the number of roots was coconut water treatment with 0% and kinetin 0 ppm.*

Introduction

Sipahutar pineapple is a long cultivated horticultural product [1]. There is prospect and potential for further development in Sipahutar district. Pineapple has the largest yield of 1,819 hectares and a production of 32,532.82 tons [2]. Pineapple is a vegetatively propagated plant; now, this commodity is very important in tropical countries [3]. Pineapple (*Ananas comosus* L.) should be developed as a plantation crop because of its economic value and market demand, it is the world's third largest export crop after the Philippines and Thailand [2]. Conventional pineapple cultivation usually uses seeds from stem shoots, fruit stalk shoots, pineapple crown shoots, tillers and stem cuttings [6]. Generally, farmers plant Sipahutar pineapple using seedlings derived from tillered stems and crowns. Using a relatively small number of seedlings derived from crowns and trunks, they are planted on a vast site. An obstacle facing Sipahutar pineapple farmers is the difficulty in obtaining pineapple seeds. One alternative that can be used to meet the needs of many seedlings is the use of in vitro culture techniques [3]. In vitro culture has several advantages, including large-scale production of seedlings of rare, endemic, and endangered plants. The seedlings produced are more resistant to pests and diseases (aseptic propagation) and have better uniformity of plant material.

The balance of growth regulators (PGR) is one factor that supports the success of in vitro culture. PGR in vitro culture can control organogenesis and morphogenesis in shoot and root formation. Auxins and cytokinins are PGRs that are commonly used in in vitro culture. Kinetin, one of the PGRs of the cytokinin class, is very effective for inducing growth in tissue culture techniques [6].

The use of coconut water in tissue culture has been widely used. The results of Katuuk's research (2000) showed that giving 250 ml/l of coconut water could accelerate the germination of tiger orchid (*Grammatohyllum scriptum*) seeds [9]. Coconut water contains natural PGR, which is included in the cytokinin group [8]. Coconut water is an organic compound often used in tissue culture engineering applications because coconut water contains 1,3 diphenylurea, zeatin, zeatin glucoside, and zeatin riboside [4]. The application of natural PGR of coconut water has been investigated to reduce the high operational costs at the laboratory level. Application of natural PGR coconut water can produce in vitro propagated pineapples plantlets that grow optimally, reducing the high operational costs at the laboratory level.

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Methodology

Location and time

This research was conducted at the YAHDI Tissue Culture Laboratory, Jalan Lambung No. 16, Perum Pelabuhan, Tanah 600, Medan Marelan and was carried out in April - July 2022.

Materials and method

Tools used are a laminar flow cabinet (LAFC), autoclave, analytical balance, refrigerator, and standard tissue culture tools. The material used was pineapple explants from Sipahutar developed at the Yahdi Tissue Culture Laboratory in Medan. All tools used in this study were sterilized in two stages. The first stage was washed thoroughly using detergent and running water using detergent and running water and followed up by using an autoclave at 121°C with a pressure of 17.5 psi for 1 hour. The materials used in this study were pineapple explants from Sipahutar (*Ananas comosus* L.), coconut water, kinetin, and MS (Murashige and Skoog) as a growing media.

Explant planting used is in vitro Sipahutar Pineapple shoots. Planting is carried out in a LAFC with a sterile planting tool. The in vitro shoots were planted into the growing medium according to treatment. After all the explants were planted, Sipahutar pineapple explants were transferred to the culture room on the plant rack. The design of this study was a factorial completely randomized design (CRD). There were 12 combinations with 3 replications so that there were 36 experimental units, after planting, the next step was observing plant growth, starting from one week old until 12 Weeks After Planting (WAP). The parameters observed in this research were: (1) Shoots growth, Observing the explants that have been planted, whether or not shoots grow until the 7th week, (2) Number of leaves, Total leaf counted every week, from the first week to 12 weeks after treatment, (3) Number of shoots, Total shoots that grow from the first week to the 12th week, (4) The number of roots, the total number of roots growing from the first week to the 12th week.

Result and discussion

Table 1. Effect of various concentrations of coconut water and kinetin on the number of pineapple shoots at the age of 12 WAP

Source of Variation	Sum of Squares (JK)	db	Mean Sum of Squares (RjK)	Significant	Conclusion
Coconut water factor	122,750	3	40,917	0,214	Not Significant
Kinetin factor	177,167	2	88,583	0,047	Significant
Coconut water factor and kinetin	135,500	6	22,583	0,520	Not Significant
Galat	611,333	24	25,472		
Total	2769,000	36			

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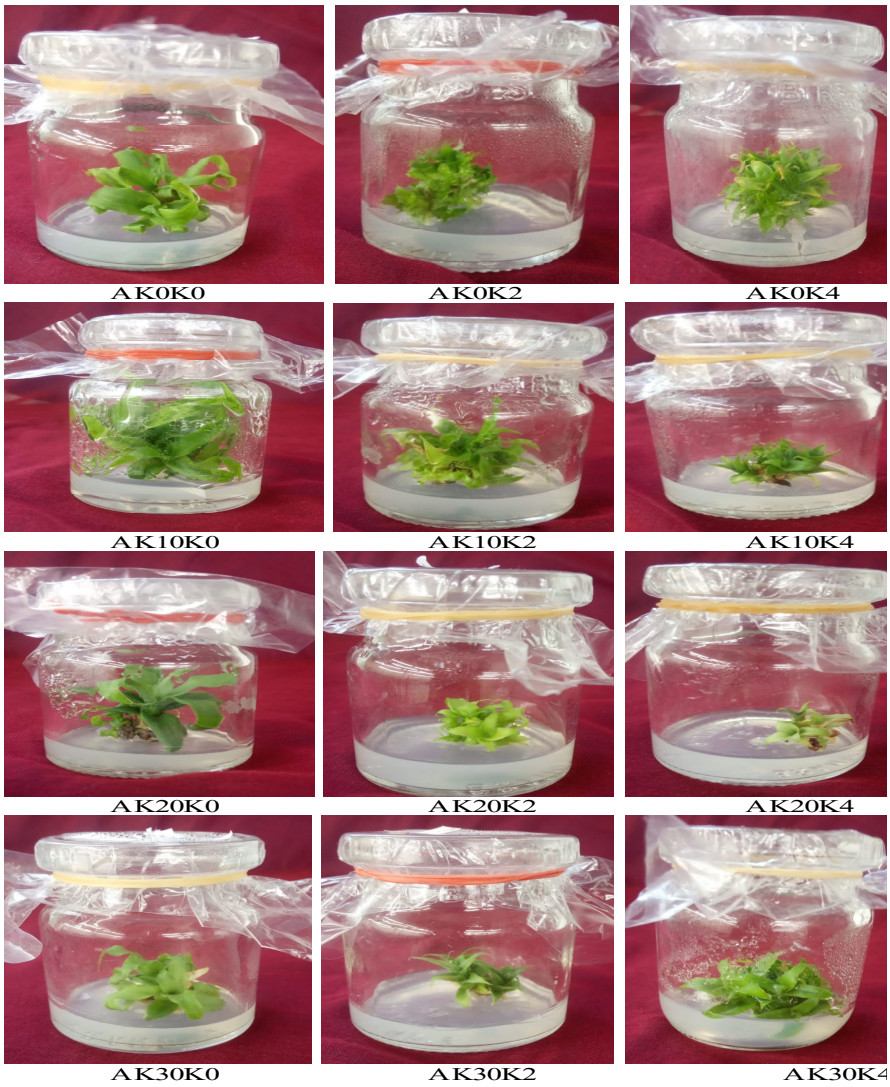


Figure 1. Number of Pineapple shoot at 12 weeks after planting, AK= coconut water, K= kinetin, sequentially AK0K0 = 0 % coconut water and 0 ppm kinetin, AK0K2 = 0 % coconut water and 2 ppm kinetin, AK0K4 =0 % coconut water and 4 ppm kinetin, AK10K0= 10 % coconut water and 0 ppm kinetin, K10K2=10 % coconut water and 2 ppm kinetin, AK10K4 =10 % coconut water and 4 ppm kinetin, AK20K0 = 20 % coconut water and 0 ppm kinetin, AK20K2 = 20 % coconut water and 2 ppm kinetin, AK20K4 = 20 % coconut water and 4 ppm kinetin, AK30K0 = 30 % coconut water and 0 ppm kinetin, AK30K2 = 30% coconut water and 2 ppm kinetin, AK30K4 = 30 % coconut water and 4 ppm kinetin

Based on table 1, the single factor of coconut water and the interaction of coconut water with kinetin did not significantly affect the number of pineapple shoots. In contrast, kinetin significantly affected the number of pineapple shoots (Figure 1). This indicates that cytokinins are essential in promoting the growth of explant shoots. According to Mahadi (2016), kinetin can stimulate the growth of stem cells by encouraging meristem cells to divide and influencing other cells to form projections.

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Table 2. Average and duncan multiple rate test of pineapple number of shoots at various concentrations of coconut water and kinetin

Coconut Water / Kinetin	0%	10%	20%	30%	Average
0 ppm	4,33	6,00	2,67	4,33	4,33a
2 ppm	9,67	8,00	5,00	4,00	6,67ab
4 ppm	14,67	6,67	5,33	12,33	9,75c
Average	9,56	6,89	4,33	6,89	

Description: Numbers followed by different letters in the same column show a significant difference (P> 0.05) in the DMRT test at the 5% level.

In table 2, from the results above, it can be seen that the interaction of kinetin administration was significantly different from the number of shots. Giving 4 ppm kinetin was the most optimal result in number of spurring shoot growth, which was 9.75 shoots. While the treatment of 0 ppm kinetin encouraged the development of the most miniature shoots, namely 4.33. Each plantlet has endogenous hormones in different concentrations, so adding growth regulators will stimulate more optimal shoot growth (Figure 2). The proper balance of endogenous PGR and exogenous PGR is essential to enable cell division in shoot and leaf primordia. Exogenous PGR added to the culture media can change the balance of PGR in plant cells, thus giving a slow response or even no response to shoot growth. This is in line with Feryati, *et al*. (2018), which state that the interaction and balance between PGR given in the media and produced by cells endogenously will determine the direction of development in culture.

Table 3. Effect of treatment with various concentrations of coconut water and kinetin on the number of leaves (strands) of pineapple at the age of 12 WAP

Source of Variation	BVCSum of Squares (JK)	Db	Mean Sum of Squares (RjK)	Significant	Conclusion
Coconut Water Factor	2100,667	3	700,222	0,144	Not Significant
Kinetin Factor	1885,722	2	942,861	0,090	Not Significant
Coconut Water Factor and Kinetin	1481,167	6	246,861	0,654	Not Significant
Galat	8498,000	24	354,083		
Total	83310,000	36			

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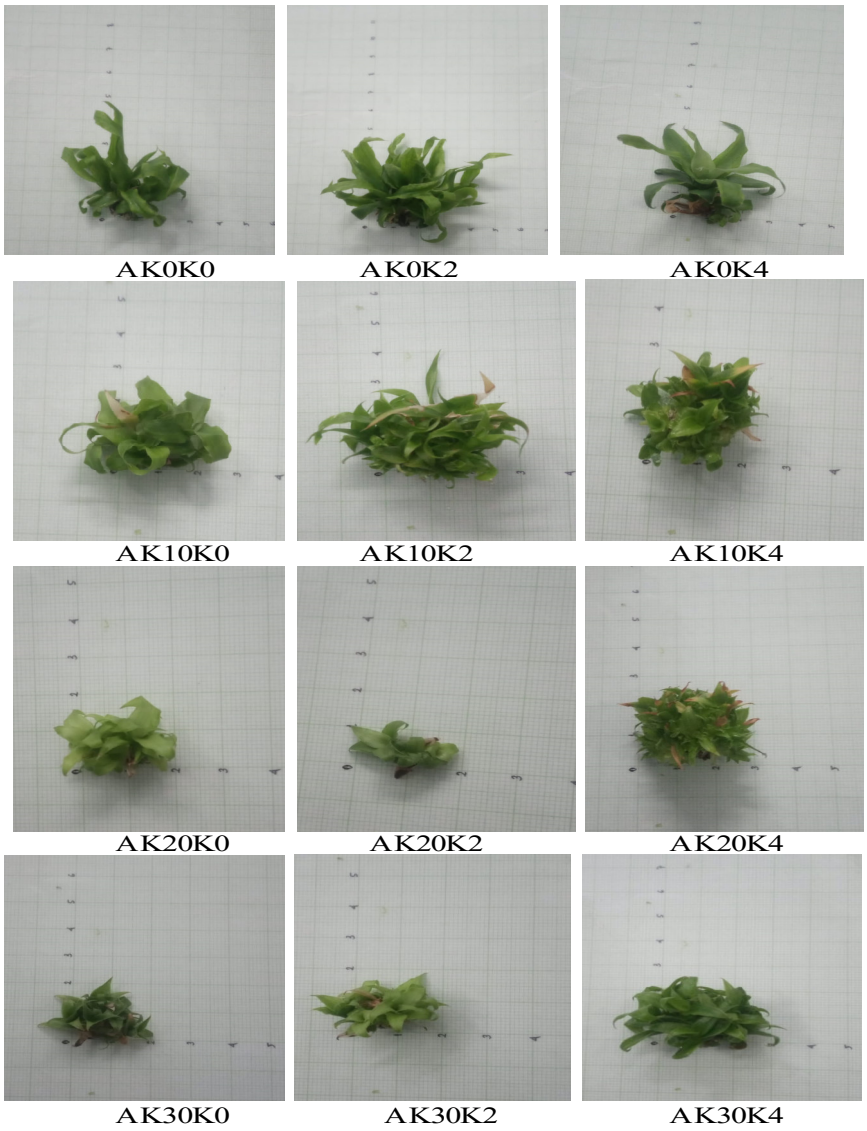


Figure 2. Appearance of Pineapple Shoot number at 12 weeks after planting AK= coconut water, K= kinetin, sequentially, AK0K0 = 0 % coconut water and 0 ppm kinetin, AK0K2 = 0 % coconut water and 2 ppm kinetin, AK0K4 =0 % coconut water and 4 ppm kinetin, AK10K0= 10 % coconut water and 0 ppm kinetin, K10K2=10 % coconut water and 2 ppm kinetin, AK10K4 =10 % coconut water and 4 ppm kinetin, AK20K0 = 20 % coconut water and 0 ppm kinetin, AK20K2 = 20 % coconut water and 2 ppm kinetin, AK20K4 = 20 % coconut water and 4 ppm kinetin, AK30K0 = 30 % coconut water and 0 ppm kinetin, AK30K2 = 30% coconut water and 2 ppm kinetin, AK30K4 = 30 % coconut water and 4 ppm kinetin.

The results of this study are as shown in table 3, coconut water, kinetin, and the interaction of coconut water and kinetin had no significant effect on the number of leaves. It can be seen that this study did not produce significance for the effect of kinetin, coconut water or their interaction on leaf number. Giving coconut water in culture media can increase the number of leaves, this is evidenced by Maninggolang (2018), with the addition of coconut water by as much as 20% can increase the number of leaves. This can be caused by the content of coconut

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water, such as elements of K, Na, Mg, and other features that plants need but not to this research, may be there are other things that have an effect on the number of leaves besides kinetin and coconut water. We can see appearance of Pineapple at 12 weeks after planting, namely performace of leaf tall and leaf width (Figure 3).

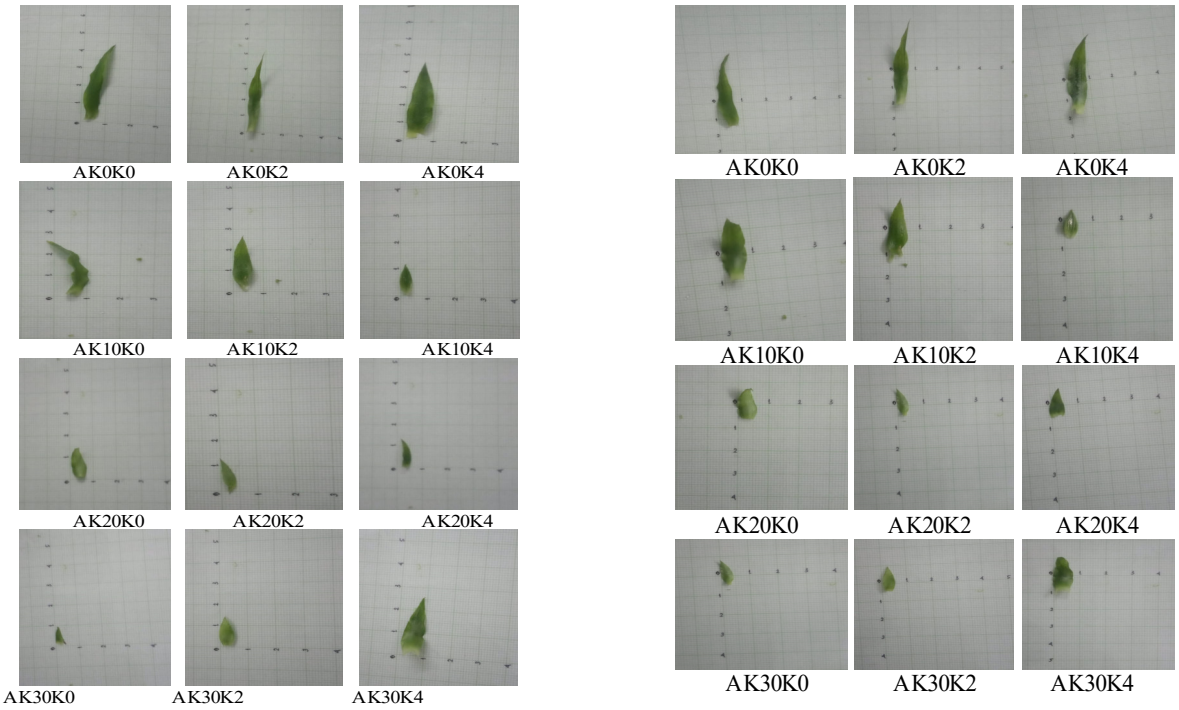


Figure 3. Appearance of leaf tall dan leaf width of pineapple at 12 weeks after planting. AK= coconut water, K= kinetin, sequentially AK0K0 = 0 % coconut water and 0 ppm kinetin, AK0K2 = 0 % coconut water and 2 ppm kinetin, AK0K4 =0 % coconut water and 4 ppm kinetin, AK10K0= 10 % coconut water and 0 ppm kinetin, K10K2=10 % coconut water and 2 ppm kinetin, AK10K4 =10 % coconut water and 4 ppm kinetin, AK20K0 = 20 % coconut water and 0 ppm kinetin, AK20K2 = 20 % coconut water and 2 ppm kinetin, AK20K4 = 20 % coconut water and 4 ppm kinetin, AK30K0 = 30 % coconut water and 0 ppm kinetin, AK30K2 = 30% coconut water and 2 ppm kinetin, AK30K4 = 30 % coconut water and 4 ppm kinetin.

Table 4. Effect of treatment with various concentrations of coconut water and kinetin on the number of pineapple roots at the age of 12 WAP

Source of Variation	Sum of Squares (JK)	db	Mean Sum of Squares (RjK)	Significant	Conclusion
CoconutWater	8,083	3	2,694	0,000	Significant
Kinetin Factor	10,167	2	5,083	0,000	Significant
Coconut Water and Kinetin	17,833	6	2,972	0,000	Significant
Galat	6,667	24	0,278		
Total	49,000	36			

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Table 5. Average and different test of pineapple root amounts at various concentrations of coconut water and kinetin

Coconut Water / Kinetin	0%	10%	20%	30%	Average
0 ppm	3,67b	0,00a	0,33a	0,67a	1,17
2 ppm	0,00a	0,00a	0,33a	0,00a	0,83
4 ppm	0,00a	0,00a	0,00a	0,00a	0,00
Average	1,22	0,00	0,22	0,22	

Description: Numbers followed by different letters in the same column show a significant difference (P> 0.05) in the DMRT test at the 5% level.

Table 6. DMRT test of pineapple root amounts at various concentrations of coconut water and kinetin

No.	Treatment	Average amount of leave
1	Ak0K0	3,67b
2	Ak0K2	0,00a
3	Ak0K4	0,00a
4	Ak10K0	0,00a
5	Ak10K2	0,00a
6	Ak10K4	0,00a
7	Ak20K0	0,33a
8	Ak20K2	0,33a
9	Ak20K4	0,00a
10	Ak30K0	0,67a
11	Ak30K2	0,00a
12	Ak30K4	0,00a

Description: Numbers followed by different letters in the same column show a significant difference (P> 0.05) in the DMRT test at the 5% level.

AK0K0 = 0 % coconut water and 0 ppm kinetin, AK0K2 = 0 % coconut water and 2 ppm kinetin, AK0K4 =0 % coconut water and 4 ppm kinetin, AK10K0= 10 % coconut water and 0 ppm kinetin, K10K2=10 % coconut water and 2 ppm kinetin, AK10K4 =10 % coconut water and 4 ppm kinetin, AK20K0 = 20 % coconut water and 0 ppm kinetin, AK20K2 = 20 % coconut water and 2 ppm kinetin, AK20K4 = 20 % coconut water and 4 ppm kinetin, AK30K0 = 30 % coconut water and 0 ppm kinetin, AK30K2 = 30% coconut water and 2 ppm kinetin, AK30K4 = 30 % coconut water and 4 ppm kinetin.

Based on table 4, coconut water, kinetin, and the interaction of coconut water and kinetin significantly affect the number of roots. Based on Duncan's test (table 5, 6), it can be seen that the 0 ppm kinetin treatment and 0% coconut water were significantly different from the other treatments. The highest number of roots was obtained in the AK_0K_0 treatment, which was 3.67. Even without adding exogenous PGR, plantlets could produce seeds, and it was suspected that the endogenous PGR content was sufficient to stimulate root growth. From the table, it can also be seen that as the concentration of kinetin increases, the number of roots decreases. This can be due to the high concentration of kinetin which can inhibit the growth of pineapple roots.

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Conclusion

1. Kinetin affected the increase in the number of shots. Still, coconut water and the interaction of coconut water and kinetin did not affect the increase in the number of pineapple shoots.
2. Coconut water, kinetin, and the interaction of coconut water and kinetin did not affect the increase in the number of pineapple leaves.
3. Coconut water, kinetin, and the interaction of coconut water and kinetin affect the increase in the number of pineapple roots.
4. The higher the concentration of kinetin, the lower the number of roots formed.
5. It takes a specific combination to increase the number of shoots, leaves, and pineapple roots.

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Improving used cooking oil quality with adsorption of Fe-Cu activated carbon derived from oil palm empty bunches

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Abstract. *This research was conducted with the aim of processing used cooking oil to reduce Free Fatty Acid (FFA) levels and Peroxide Values (PV) to extend the shelf life of cooking oils by using adsorption treatment before being disposed of because the quality of the oil has decreased. Activated Carbon is derived from solid waste of Oil Palm Empty Bunches (OPEB), and then modified using Fe-Cu refer to Fe-Cu Activated Carbon (FCAC). AC and FCAC were characterized using XRD showing an amorphous structure with a slightly different level of crystallinity. The increasing amount of AC and FCAC used in the adsorption process, induce the greater decreasing of Free Fatty Acid Number (FFA) and Peroxide Number (PV) in used cooking oil. AC reduced FFA from 1.43 % up to 0.76% and the peroxide number from 10 mekO_2/kg was reduced to 3.98 mekO_2/kg. While FCAC can reduce FFA up to 0.56% and PV up to 1.98 mekO_2/kg. The capability adsorption of FCAC was better in reducing of Free Fatty Acids and Peroxide Numbers in used cooking oil on purpose to increasing their quality. The presence of Fe and Cu metals in the structure of activated carbon gives the active side properties of activated carbon to adsorb contaminants in the oil as a contributor to the large FFA and PV values due to repeated use. This activated carbon modification become a new strategy to improve activated carbon adsorption properties.*

Keywords: oil palm empty bunches, adsorption, activated carbon, modified activated carbon

Introduction

Cooking oil is one of the basic human needs which is used as a medium for processing food ingredients. The need for cooking oil will increase with the increasing population in Indonesia, so that the used cooking oil produced will increase. Cooking oil that is used repeatedly and continuously during the frying process causes a degradation reaction which reduces the quality of the cooking oil. Fat damage that occurs in the frying process is caused by exposure (contact) of oil to the air, excessive heating, contact of oil with food, and the presence of charred ingredients during the frying process [1,2].

Refining used cooking oil is the separation of degradation reaction products (water, peroxide, free fatty acids, aldehydes and ketones) from oil. Several ways can be done to purify used cooking oil, namely the process of separation with membrane extraction using supercritical fluids, and purification using various types of adsorbents. The most commonly used adsorbent is activated carbon [3-6]. Activated carbon is generally made from carbon-based materials such as carbon, lignin, lignocellulosic materials, synthetic polymers, and carbon waste. Activated carbon is a material in the form of granules or powder obtained from carbonaceous materials such as reinforcement, soft wood, rice husks, corn cobs, coconut coir, sugar cane milling waste, paper-making waste, sawdust, hard wood, charcoal and so on [7,8].

The palm oil industry as a source of cooking oil also produces a number of by-products in the form of solid and liquid waste, one of which is empty palm fruit bunches. Oil palm empty fruit bunches (OPEB) are the main lignocellulosic waste that has not been utilized optimally, so there are still many empty fruit bunches that are left unattended without any processing. Oil palm empty fruit bunches constitute 23 percent of fresh fruit bunches which contain 50-60% lignocellulosic material by dry weight. Lignocellulose is the main component of OPEB which has the ability to adsorb heavy metals because it contains active groups such as –OH and –COOH. Lignocellulose is classified as a natural and non-toxic material. Lignocellulose consists of cellulose, hemicellulose, and lignin. OPEB contains 50.9% cellulose, 26.6% hemicellulose, and 17.84% lignin , so it has the potential to be converted into activated carbon [9-15].

The addition of activated charcoal as an adsorbent to used cooking oil can absorb peroxide numbers. The peroxide absorption index process from activated carbon goes through three stages, namely the amount of peroxide adsorbed on the outside of the activated carbon, then moves in the

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direction of the carbon pores and is adsorbed on the inner wall of the activated carbon. the activated carbon. Activated carbon as an adsorbent only absorbs, does not decompose and does not react after use [16-19].

In this study, empty palm oil bunches were made into activated carbon and then modified by adding metal elements Fe and Cu which aimed to expand the surface of the adsorbent and at the same time provoke the active site of the activated carbon to absorb foreign substances.

Methodology

Materials

The materials used in this study were: empty palm oil bunches, ammonia p.a, hydrochloric acid p.a, ammonium nitrate, sulfuric acid, litmus paper, phenol phthalein indicator, methyl red and distilled water.

Methods

Preparation of oil palm empty bunches as activated carbon

Oil Palm Empty Bunches collected from Palm Oil Plantation Batang Kuis. A total of 100 g of oil palm empty bunches were collected, cleaned with distilled water. Then put it in the oven at ± 105 for 24 hours to remove the water content. After that, it was mashed using a blender and sieved with 200 mesh.

Carbonization and activation

Dry powder of oil palm empty bunches is heated in a furnace at a temperature of 500 for ± 2 minutes, after which it is placed in a closed container. The results of this carbonization are then immersed in a phosphate solution for 24 hours, then filtered using a vacuum and neutralized to a neutral pH with distilled water. This OPEFB Activated Carbon is then baked in an oven at 105 for 1 hour, after which it is cooled to room temperature.

Fe-Cu activated carbon modification

15 grams of activated carbon is added to 150 mL of Fe and Cu with the ratio; 1 : 1. Then heated for 3 hours, cooled and filtered. Then put in the oven at 105 ^{o}C for 24 hours.

Adsorption process

Effect of activated carbon weight

A total of 100 mL of used cooking oil sample was put into a beaker glass. Then added activated carbon with mass variations of 4 g, 6 g, and 8 g in the beaker glass, stirred using a magnetic stirrer for 90 minutes. After that, the used cooking oil is filtered and the filtrate is collected.

Effect of adsorption time

A total of 100 mL of used cooking oil sample was put into a beaker glass. Then added activated carbon according to the optimum mass that has been obtained previously and stirred using a magnetic stirrer with variations in contact time for 30 minutes, 60 minutes and 90 minutes. After that, the used cooking oil is filtered and the filtrate is collected.

Results and discussion

The XRD pattern (Figure 1) shows a slightly change in the structure of activated carbon after the presence of Fe and Cu metals even though they are both formed as amorphous. In the Fe-Cu modified activated carbon there is an increase in the peak, but the intensity is weak. The increase occurs at an angle of 2θ between 43º to 64º. The peaks indicate the presence of crystal peaks which may indicate the presence of Fe and Cu due to the modification process. This is also supported by

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the results of the EDX characterization which showed the presence of Fe-Cu ions that entered the cavity or surface of the modified activated carbon. It can also be said that the crystallinity of ACFC is greater than that of AC.

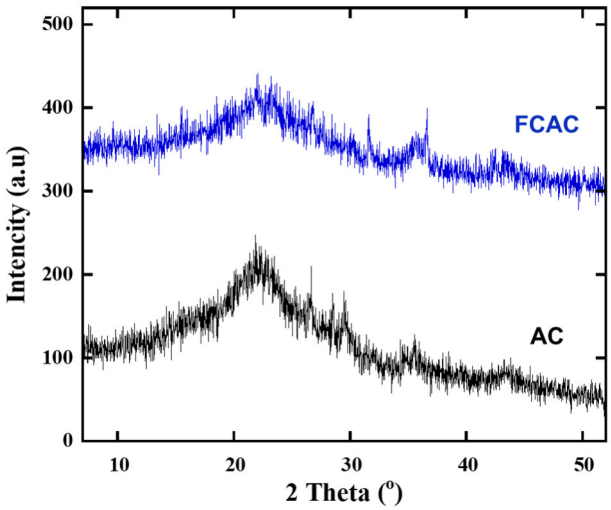


Figure 1. XRD patterns of OPEB Activated Carbon (AC) and OPEB Fe-Cu Activated Carbon (FCAC)

Effect of activated carbon weight in Free Fatty Acid (FFA) content

Used cooking oil samples were taken from a fried food vendor who was on Pancing Street, in front of MMTC, Medan. The used cooking oil sample is the result of frying 2-3 times used. Cooking oil before being analyzed is filtered first to remove impurities in the form of solids or remnants of frying. The color of used cooking oil is clear yellow and not too thick. The smell of the oil is not rancid and still smells like normal oil. Then the oil is tested for free fatty acid levels and its peroxide value. The test results showed that the free fatty acid (FFA) content was 1.43% and the peroxide value (PV) was 10.0 meq O_2/kg. The following is table 4.6 the results of the used cooking oil quality test before adsorption.

The results of determining the free fatty acid levels of used cooking oil after the adsorption process using the mass variation of activated carbon and Fe-Cu modified activated carbon from empty palm oil bunches can be seen in Figure 2. Reduction of free fatty acid content using activated carbon and Fe-Cu modified activated carbon of empty palm oil bunches. The lowest reduction in free fatty acid content using activated carbon was found in the optimum activated carbon mass (highest absorption) of 10 g with an FFA percentage of 0.87 %. While the decrease in free fatty acid levels using the optimum Fe-Cu modified activated carbon was 8 g with an FFA percent of 0.56 %. And it can be seen that the efficiency and adsorption capacity (absorption) of Fe-Cu modified activated carbon is greater than that of unmodified activated carbon.

From these results it can be seen that there is an effect of adding adsorbent mass on reducing free fatty acid levels in used cooking oil, where the more adsorbent mass used, the greater the decrease in free fatty acid levels. However, excessive use of adsorbents also has a negative impact, because it can trigger the formation of free fatty acid compounds which increase again. This is possible because in the adsorption process between the adsorbent and the oil is oversaturated resulting in desorption of absorbed free fatty acids [20,21].

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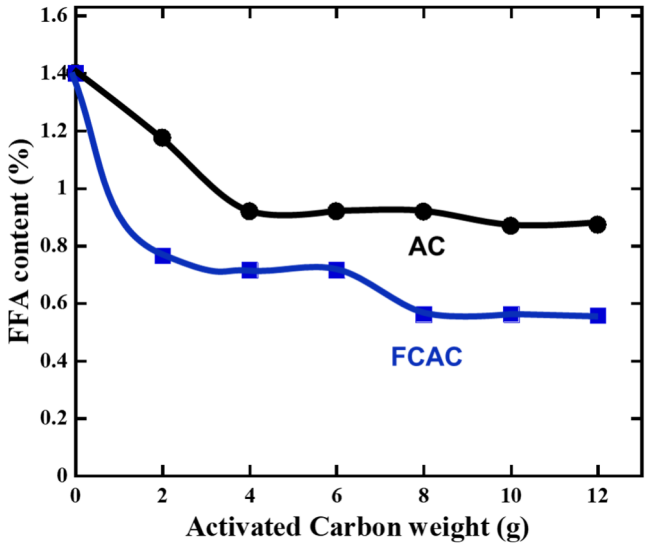


Figure 2. Analysis of free fatty acid content with mass variation

Effect of activated carbon weight in Peroxide Value (PV)

Peroxide number is defined as the amount of meq peroxide in every 1000 g of oil sample. Determination of the peroxide number is used to indicate the degree of damage to the oil. The determination of PV was carried out by iodometric titration method using sodium thiosulfate solution. In the process, oil is added with chloroform which functions as a non-polar solvent and glacial acetic acid so that the color of the solution changes to light yellow, in which the mixed solution makes the pH of the oil acidic so that a saturated KI solution can react directly with peroxide compounds.

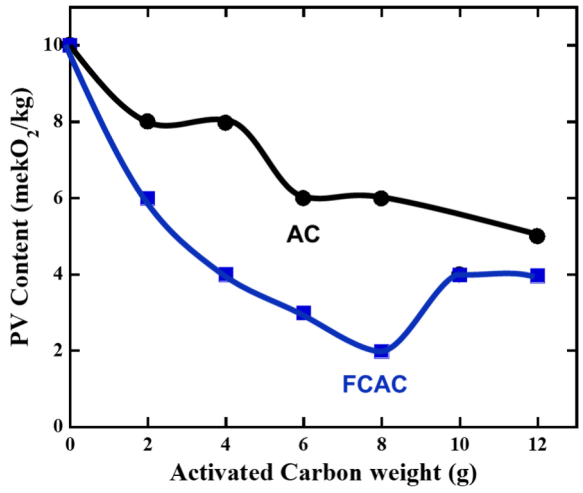


Figure 3. Analysis of Peroxide Value (PV) with mass variation

The results of determining the peroxide value of used cooking oil after the adsorption process using variations in the mass of activated carbon and Fe-Cu modified activated carbon from empty palm oil bunches can be seen in Figure 3. Based on Figure 3, it can be seen that the mass variation of the adsorbent has an effect on decreasing the peroxide number in used cooking oil. Where, the more mass of activated carbon and Fe-Cu modified activated carbon used in the adsorption

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process, the higher the decrease in the level of peroxide number (absorption). The decrease in the optimum peroxide number using activated carbon and Fe-Cu modified activated carbon found in the adsorbent mass of 10 grams respectively with a PV value of 3.98 meq O_2/kg and 8 grams with a PV value of 1.98 meq O_2/kg. This shows that the more mass of the adsorbent, the greater the number of peroxides absorbed.

Activated carbon is able to absorb anions, cations and molecules in the form of organic and inorganic compounds in the form of solutions and gases, therefore it is used as an adsorbent for weak pollutants in industrial products. Activated carbon has non-polar properties, this property makes the smell and color of the oil more easily absorbed and the amount of peroxide is reduced to improve the quality of the oil. The process of absorption of the peroxide by activated carbon goes through three stages, namely the amount of peroxide which is adsorbed on the outside of the activated carbon, then moves in the direction of the carbon pores and is adsorbed on the internal activated carbon wall [22,23].

Effect of adsorption time in Free Fatty Acid (FFA) content

The efficiency values of activated carbon and modified activated carbon for each contact time variation can be seen in Figure 4. It can be seen that there is a decrease in free fatty acid levels using activated carbon and Fe-Cu modified activated carbon as the contact time increases. worn. Optimum free fatty acid reduction using activated carbon and Fe-Cu modified activated carbon occurred at the same contact time of 120 minutes. The free fatty acid content of used cooking oil adsorbed using activated carbon was 0.76%, while the free fatty acid content of used cooking oil adsorbed using Fe-Cu modified activated carbon was 0.56%. This shows that the longer the contact time used in the adsorption process, the greater the absorption of free fatty acid levels in the oil by the adsorbent. And it can be seen that the Fe-Cu modified activated carbon is better than the unmodified activated carbon for adsorbing used cooking oil in reducing its free fatty acid content.

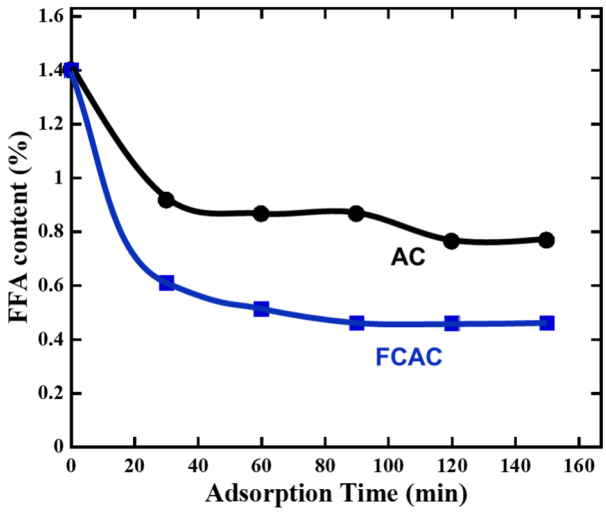


Figure 4. Analysis of Free Fatty Acid content with Adsorption Time Variation

The decrease in free fatty acid levels was due to the adsorption process between the surface of the activated carbon and free fatty acids in used cooking oil. The acidic organic compounds will be well adsorbed with polar adsorbents. Activated carbon activated with phosphoric acid is expected to have polar properties so that it can reduce the levels of polar free fatty acids also in used cooking oil. The adsorption process is influenced by the surface area of the adsorbent which

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will determine the adsorption capacity and kinetics [5,24]. The length of contact time affects the absorption of free fatty acid levels. The adsorption equilibrium time depends on the structure and chemical properties of the adsorbent, the dose and temperature of the adsorbent. The greater the dose of adsorbent used, the greater the percentage of free fatty acid reduction in used cooking oil because the more mass it will provide more active surface area to absorb the free fatty acids.

The Indonesian National Standard (SNI) of 3741-2013 standard for the free fatty acid content of used cooking oil is 0.3%. Based on the results of the study, the free fatty acid content of used cooking oil after the adsorption process with an optimum mass of 8 grams and an optimum contact time of 120 minutes obtained the lowest value of 0.5601%. Based on these data, it can be concluded that used cooking oil after adsorption with activated carbon and Fe-Cu modified activated carbon from empty palm oil bunches does not meet the standard requirements of SNI 3741-2013.

Effect of adsorption time in Peroxide Value (PV)

Figure 5 shows the decrease in peroxide number after adsorption using activated carbon and Fe-Cu modified activated carbon with increasing contact time in the adsorption process. The optimum decrease in peroxide value using activated carbon and Fe-Cu modified activated carbon occurred at the same contact time of 120 minutes, with peroxide number values of 3.98 meq O_2/kg and 1.98 meq O_2/kg, respectively. This shows that the longer the contact time during the adsorption process, the greater the amount of peroxide absorbed by the adsorbent in used cooking oil.

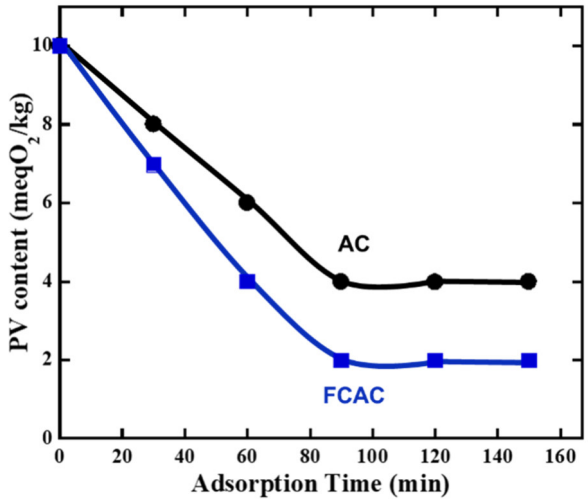


Figure 3. Analysis of Peroxide Value with adsorption time variation

The use of activated carbon and Fe-Cu modified activated carbon is proven to reduce the value of peroxide value in used cooking oil. The ability of activated carbon to absorb peroxides in oil is caused by activated carbon which has been activated with phosphoric acid which is polar so that it has a large enough affinity to bind or absorb polar solutes. Peroxide compounds contained in used cooking oil contain peroxide groups which are also polar, so they are easily absorbed by the surface of activated carbon which is also polar.

The way to calculate peroxide can be called iodometry because the iodine to be measured by thiosulfate solution comes from a redox process (reaction) in which the peroxide compound which functions as an oxidizing agent oxidizes potassium iodide solution. Consequently, this reaction is known as an indirect titration. The stages of this reaction are:

$$I_2 + 2Na_2S_2O_3 \Rightarrow 2NaI + Na_2S_4O_6$$

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In the initial step of oxidation, peroxide is produced. Quantum energy can remove a hydrogen atom from a double bonded carbon atom that is close to another carbon atom to create free radicals. In this oxidation stage, unsaturated fatty acid molecules are used as a source of hydrogen to produce free radicals [25,26]. Oil molecules containing free radicals are oxidized. These radicals then combine with oxygen to form peroxy radicals (active peroxides), which can then be converted to hydroperoxides. Hydroperoxides are very unstable and break down easily into compounds with shorter carbon chains, where they can then absorb hydrogen from additional unsaturated molecules to make new peroxides and free radicals. High radiation, heat energy, metal catalysts or enzymes all speed it up. Compounds [27,28].

The optimum value at the time of adsorption can be seen when there is a decrease in adsorption on the peroxide number, where the peroxide number value increases again. This is caused because the adsorbent is no longer able to absorb the adsorbate. This decrease in adsorption value indicates that the activated carbon undergoes desorption, i.e. releases back the used cooking oil sample, or it can be interpreted that when the adsorption process is carried out for a longer time, the activated carbon which has absorbed peroxide optimally will be released back into the oil. This is because activated carbon has the maximum absorption capacity in absorbing.

SNI 37-41-2013 for cooking oil number is 10 meq O_2/kg. Based on the results of the study, the peroxide value of used cooking oil after the adsorption process with an optimum mass of 8 grams and an optimum contact time of 120 minutes obtained the lowest value of 1.9872 meq O_2/kg. Based on these data, it can be concluded that used cooking oil after adsorption with activated carbon and Fe-Cu modified activated carbon from empty palm oil bunches meets the standard requirements of SNI 3741-2013.

Conclusion

The more mass of activated carbon and Fe-Cu modified activated carbon used in the adsorption process, the greater the absorption of free fatty acid numbers and peroxide numbers in used cooking oil. Likewise, with the contact time used in the adsorption process. The results showed that the optimum conditions for adsorption using 10 grams of activated carbon in 120 minutes reduced FFA up to 0.76 % and PV up to 3.98 meq O_2/kg. Then the results of optimum conditions when adsorption using 8 grams of Fe-Cu modified activated carbon at 120 minutes can reduce FFA to 0.56 % and PV to 1.98 meq O_2/kg. Activated carbon and Fe-Cu modified activated carbon can reduce the levels of free fatty acids and peroxide value in used cooking oil. Where the efficiency and adsorption capacity of modified activated carbon is better in absorbing free fatty acids and their peroxide value.

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Optimization of oil palm empty bunches as modification adsorbent to reduce TSS in water treatment

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Abstract. *The purpose of this research was to reduce TSS in water by optimizing OPEB as an adsorbent. This OPEB was formed into activated carbon and was modified by using Fe-Cu metal. Both activated carbon and modified Fe-Cu metal were characterized using XRD and SEM-EDX. XRD pattern showed an amorphous structure with different structural properties. SEM-EDX result showed the presence of Fe-Cu metal effect on morphology which becomes compact. The result of OPEB adsorption showed that activated carbon reduced TSS from 540 ppm to 160 ppm whereas modified activated carbon reduced TSS from 540 ppm to 80 ppm. Although the quality of this water still does not meet drinking water standards but the effectivity of modified carbon active need to be considerable.*

Keywords: adsorption, adsorbent, oil palm empty bunches, TSS, water quality

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Introduction

Water is the source of life for humans and living things. The role of groundwater is increasingly important because groundwater is the main source of water to meet the basic needs of many people's lives. It is estimated that 70% of the population's clean water needs and 90% of industrial water needs come from groundwater. In terms of quality, groundwater is one of the good water resources for drinking water [1].

The importance of water in life makes water quality must meet the requirements of chemical, biological and physical parameters [2-3]. The decline in water quality will reduce the usability, usability, productivity, and capacity of water resources which in turn will reduce the wealth of natural resources [4-6].

World Health Organization (WHO) and other regulatory bodies stated that one of parameter that can affected drinking water quality is Total Suspended Solids (TSS). Moreover, the investigation of the drinking water quality by researchers and governmental departments has been performed regularly. Whereas, when the value is higher than a certain concentration can cause detrimental impacts on human health [7-9].

Activated carbon adsorption is considered an efficient method for removing organic pollutants in both drinking water and wastewater due to its high efficiency and ease of operation. However, the price of commercially activated carbon has made many researchers look for low-priced substitutes as an alternative to the manufacture of activated carbon. The use of activated carbon can be maximized with modifications to activated carbon. Previous research mention that the activated carbon surface after modification with Fe-Cu was smaller in size than before modification which allows a larger surface area to increase its adsorption ability. The Fe-Cu modified carbon is expected to increase the absorption of impurities in the water when tested in the water absorption process [10-12].

One of the materials that can be used as activated carbon is Oil Palm Empty Bunches (OPEB). OPEB is solid waste that can be reprocessed into useful materials. OPEB has a high cellulose content. Biomass is abundant with carbon. The presence of carbon makes OPEB a very good potential raw material in the manufacture of activated carbon [13-14].

Palm oil is one of the plantation commodities that continues to grow in Indonesia. Palm oil mills produce 75% of waste (solid and liquid). This waste is an environmental issue and requires serious handling [15-16].

Methodology

Materials

Glassware, analytical balance, 200 mesh sieve, oven, hot plate, titration apparatus, condenser, furnace, X-ray diffractometer (XRD), Scanning Electron Microscope-Energy Dispersive X-ray (SEM-EDX), pH meter and AAS. Oil Palm Empty Bunches (OPEB), H_3PO_4, H_2SO_4, $CuSO_4$, distilled water, Whatman filter paper, FAS (ferro ammonium sulfate).

Methods

OPEB were collected from PT Multi Agro Sumatera. A total of 100 grams, then washed in running water and distilled water until clean, then cut into small pieces (2mm) to facilitate the pyrolysis process. Put in the oven with a temperature of ± 105°C for 24 hours, then mashed with a blender and sieve using a 200 mesh sieve [11]. OPEB adsorbent had been characterization then made it into biosorbent carbonization. Furthermore, this biosorbent was activated into activated

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carbon and modified with Fe-Cu Metal [8]. Water quality analysis of total suspended solid (TSS) was analyzed by gravimetry method [12].

Results and discussion

Morphological analysis of EFB biosorbent and activated carbon using SEM (Scanning Electron Microscopy) with 1000x magnification to determine the surface shape of biosorbent, activated carbon and modified activated carbon as shown in Figure 1.

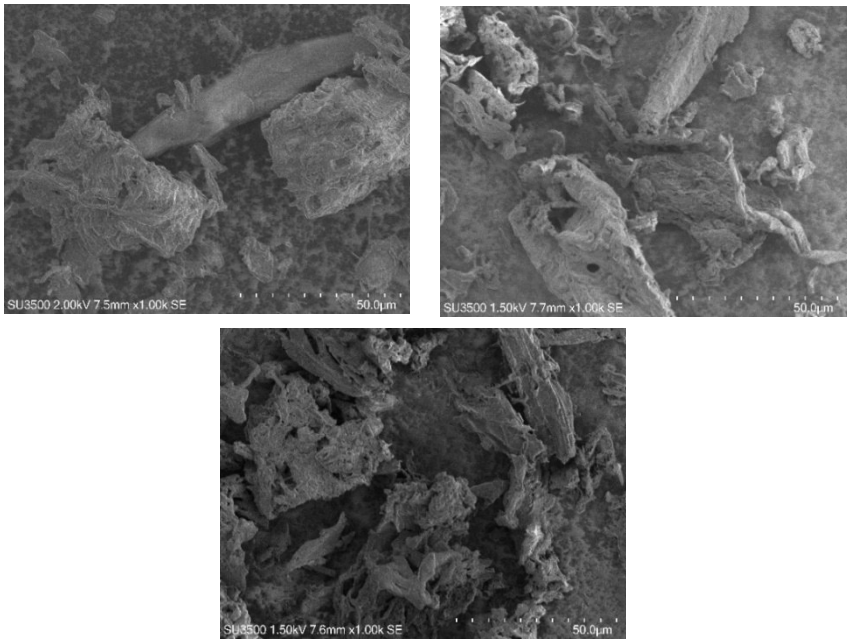


Figure1. SEM morphology of Biosorbent (top left), activated carbon (top right) and modified activated carbon (bottom)

It can be seen that the morphology of the biosorbent has large lumps and is rough in shape. On the surface of the biosorbent, there are few pores formed and the shape of the surface is irregular, the lumps formed can be in the form of impurities that cover the surface of the pores in the biosorbent.

The surface of the activated carbon is more regular and even compare with the surface of the biosorbent. In activated carbon, the pores are more open and clean than in biosorbents due to the influence of the carbonization and activation processes. The more pores and less ash or impurities on the activated carbon, the greater the ability of activated carbon for the adsorption process will be. The pores formed are derived from the evaporation of the organic content contained in the biosorbent during the carbonization process.

The modified activated carbon shows a slightly more regular and even surface morphology compared to activated carbon. In modified activated carbon the bulkhead or threaded surface structure was more hollow than activated carbon. This difference can be caused by the addition of Fe and Cu metals to the carbon so that the structure changes. The XRD pattern shows in Figure 2.

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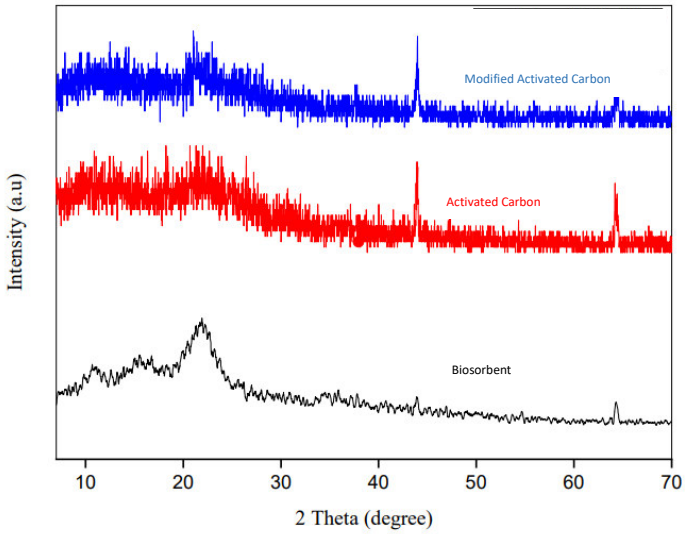


Figure 2. XRD pattern of biosorbent, activated carbon and modified activated carbon of OPEFB

Based on figure 2, the shape of the graph that appears has a slight difference. This can be influenced by the degree of crystallinity formed. In the picture, it can be seen that the graph shows the crystallinity of the biosorbent, activated carbon and activated carbon modified by Fe-Cu have an amorphous material structure.

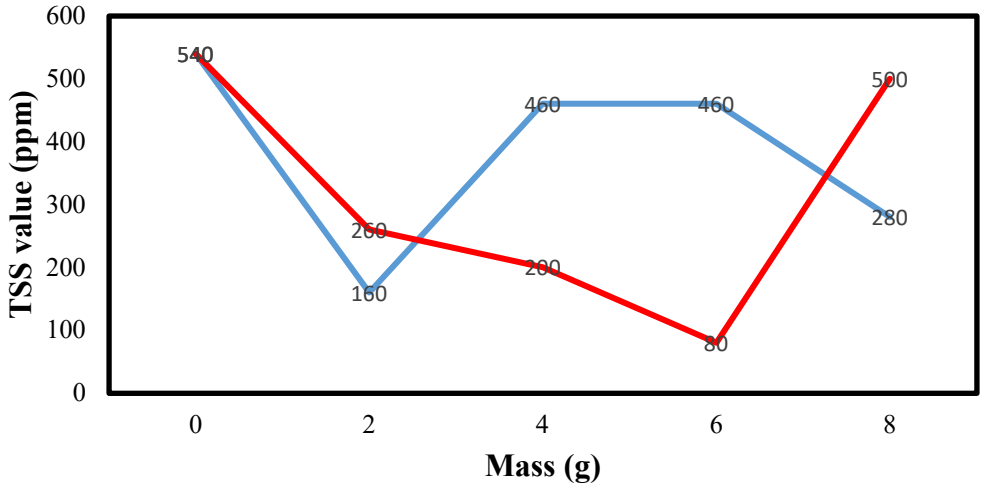


Figure 3. Effect of adsorbent on TSS levels by adsorption of OPEFB-activated carbon and Fe-Cu OPEFB-activated carbon

Based on Figure 3, it shows that the optimum condition for OPEFB KA is 2 grams, which reduces the TSS value from 540 to 180 ppm, while for Modified OPEFB KA the optimum value is when the mass is 6 grams, which reduces the value from 540 to 80. The results in This TSS shows a slightly different value from the previous variable where the optimum mass for both TKKS and modified TKKS is 2 grams. Although TKKS KA and TKKS Modified KA have succeeded in reducing the TSS value in water quite high, it turns out that this value is still not

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able to make the water consumable or also for household needs. The TSS standard set according to the regulations is 50 ppm.

Conclusion

SEM morphology on modified activated can be seen on the modified activated carbon surface morphology is more compact with cleaner, visible pores and makes the distance on the carbon more structured. XRD characterization showed was amorphous. Both activated carbon and modified activated carbon reduced TSS value. Although this water quality does not meet drinking water standards but the effectivity of modified carbon active need to be considerable.

Acknowledgments

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Ethanol extract of frankincense gum (*Styrax benzoin*)

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Abstract. *Frankincense (Styrax benzoin) is a plant that is commonly found in North Sumatra, Indonesia. The gum produced from frankincense has many benefits and is very important in the world of industrialization, especially in the pharmaceutical field. In order to keep abreast of high market developments, fast and efficient techniques are needed to produce a preparation. The purpose of this study was to obtain the best method for producing frankincense latex extract by retaining the active compounds contained therein. The extraction method used was soxhletation with 96% ethanol and phytochemical screening was carried out to identify secondary metabolite components. The stability of the extract was increased using propylene glycol and tween 80 as cosolvent. The ethanol extract of frankincense gum was standardized based on specific and non-specific parameters. The results of the study obtained a total yield of 68.59% in the form of a thick blackish brown liquid with a distinctive frankincense aroma with a pH value of 4.8 and a viscosity of 67,245 cP. The ethanol extract of frankincense gum was identified to contain alkaloids, flavonoids, tannins, and gumonins through phytochemical screening as well as bezoic acid (41.62%) and cinnamic acid (100%) through GC-MS. This shows that the soxhletation method can be used to produce frankincense gum extract by retaining the active compounds contained in the extract.*

Keywords: *frankincense, soxhletation, cosolvation*

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Introduction

Frankincense plants in Indonesia are found in North Sumatra, West Kalimantan, and Western Java [1]. Data from BPS North Sumatra frankincense plantation area of 23.146 hectares in 2020 this area affects the yield of 8.604 tons. An increase in crop production resulted in an increase in state profits. Frankincense gum sold by frankincense farmers is in the form of chunks (raw materials) at different prices according to the quality of the frankincense sold [2].

It was recorded that the content of cinnamic acid and benzoic acid levels was 26.43% and 3.35% in the frankincense gum of North Tapanuli, North Sumatra using the Gas Chromatography method. Sumatran frankincense also contains many phenyl propanoid derivative compounds such as, benzaldehyde, vanillin, styrosol, phenyl propyl synamate, also contains benzoresinol esters, alcohol coniferyl esters of cinnamic acid and benzoic acid [3].

Based on observations, frankincense extract preparations on the market are quite expensive. However, the extract experienced sedimentation or flocculation as the 30 day time approached. This indicates that the solubility level of the extract has decreased or is unstable within a certain period of time [4]. One way to increase solubility is through the use of a mixture of several types of solvents. This phenomenon is known as cosolvency, while the solvent in the mixed solvent that can increase the solubility of a substance is called cosolvent [5]. Stable extract preparations are preparations that are still within acceptable limits during the period of storage and use [6].

Based on previous studies that used the maceration extraction method to extract frankincense gum, it showed that the active compounds cinnamic acid (100%) and benzoic acid (45.58%) were present in the frankincense gum. This study also proves the presence of alkaloids, flavonoids, gumonins, tannins, and terpenoids in the ethanol extract of frankincense gum [7].

In order to keep abreast of high market developments, fast and efficient techniques are needed to produce a preparation. One of the most effective methods and methods for extracting bioactive compounds is Soxhletation. The principle of Soxhletation is repeated filtering so that the results obtained are perfect and the solvent used is relatively small. Soxhlet produces a greater yield when compared to maceration. This is due to the presence of heat treatment which can increase the ability of the solvent to extract compounds that are insoluble at room temperature conditions, as well as the maximum withdrawal of compounds by the solvent which is always circulating in the process of contact with simplicia so that the yield increases [8].

Based on the description above, a study was conducted on the Soxhletation method in producing frankincense gum extract using ethanol as a solvent. The purpose of this study was to obtain the best method for producing frankincense gum extract by retaining the active compounds contained therein.

Methodology

Tools and materials

The tools used in this study are a set of glassware, titration tools, a set of soxhlet tools, an analytical balance, a split funnel, an ostwald viscometer, a pycnometer, a hotplate, a pH meters, a rotary evaporator, an 80 mesh sieve, a magnetic stirrer, and a GC-MS 7890B.

The materials used in this study were frankincense gum powder measuring 80 mesh from the Parsoburan area, 96% Ethanol, Dragendorff's reagent, Iron(III) chloride 1%, Iron(III) chloride 5%, acetic acid, sulfuric acid, hydrochloric acid, Phenolphthalein Indicator, Potassium Hydroxide (KOH), Propylene Glycol (PG), Tween 80, Aquades, and Alcohol 96%.

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Procedure

Frankincense gum extraction

30 g of freshly ground frankincense gum resin was extracted with 150 ml of solvent by the Soxhlet method. The solvent used is 96% ethanol. The reaction temperature is set on the heating mantle based on the boiling point of the solvent (78℃). The oil separated from the resin is collected back in a round base lask along with the solvent. Then the oil is separated from the solvent using rotary evaporator equipment [9]. After the thick extract was obtained, the yield was calculated using the AOAC formula [10] with the following formula:

$$\%\ yield\ = \frac{extract\ weight}{raw\ material\ weight} \times\ 100\%$$

Phytochemical screening

Then flavonoid identification was carried out by inserting the sample into a test tube and then added $FeCl_3$ 5%. The test will be positive if it appears red. Identification of alkaloid compounds was carried out with the Dragendorff's reagent, it was seen the formation of brick-red deposits that showed a positive test for alkaloids. While in the tannin test given a 1% $FeCl_3$ change, the test will be positive if there is a change in blackish green color. Identification of gumonins compounds is carried out by adding heated aqueous, then HCl. Filtrate is shaken. The formation of a layer of foam indicates the presence of gumonins. Identification of Terpenoid compounds is carried out by the Liebermann-Buchard method, namely by adding acetic acid and then allowing it to stand, then concentrated sulfuric acid is added. A positive terpenoid test is indicated by the occurrence of an orange or purple color [11].

Increasing stability

5 mL of sample was added to the beaker glass containing 5 mL of propylene glycol with a concentration of 75% (w/v) and 2 mL of Tween 80, then stirred at a speed of 150 revolutions min using a magnetic stirrer at 25°C. After equilibrium is achieved, the saturated solution is [12]. The stability of the extract can be seen from organoleptic testing.

pH test

pH examination is carried out using a pH meter, the basis of the sensor in the form of a glass electrode works to measure the concentration of hydrogen ions from the solution [13].

Viscosity test

Viscosity measurement is by using an ostwald viscometer. Its determination is carried out by means of measuring the time it takes for the flow of the cosolvent solution in the capillary pipe from a to b. Cosolvent solution is fed into the viscometer. Kosolven's solution is sucked in with a pump until it is above the mark a. The liquid is allowed to flow down and the time required from a to b is recorded using a stopwatch.

Identification of chemical ingredients of extract

Chemical content levels were analyzed using gas chromatography instruments [14]. The extract analysis was carried out at the Medan Customs Laboratory. The solution was analyzed with GC-MS using the GCMS 7890B system, with columns HP1 (30 m x 250 µm x 0.25 µm). The initial temperature of the GC oven is 90°C and is programmed to 110°C at a certain speed of 15°C/min and goes to 240°C for 22 minutes under the following conditions: carrier gas, helium; injector and

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detector temperature, 280°C; injected volume, 1µl (20% hexane solution). The mass spectrum is carried out on normal scanning, mass range 30-450.

Result and discussion

In this study, a soxhletation method was carried out to extract frankincense gum powder. The soxhletation method was chosen because of the heat treatment that can increase the ability of the solvent to extract insoluble compounds under room temperature conditions, there is a more maximum withdrawal of compounds by solvents that always circulate in the process of contact with simplicia so that the yield increases, and does not require filtration. The extraction of 30 g of frankincense gum powder uses a 96% ethanol solvent because it can attract the overall compounds contained in the frankincense gum powder which is polar. The soxhletation process uses a temperature of 78°C with a ratio of incense gum powder and ethanol solvent (1:5). Soxhlet extraction to obtain colorless droplets (perfectly extracted) which is 9 hours. The results of soxhletation were concentrated with a rotary evaporator at a temperature of 75°C with the aim of removing the solvent so that a thick extract of frankincense gum was brownish black.



Figure 1. Viscous extract of frankincense gum

The extract yield was calculated by comparing the weight of the frankincense gum ethanol extract obtained against the amount of frankincense gum powder used in the extraction process. The yield obtained using soxhletation extraction was 68.59%. The acquisition of amendments is through the following calculations:

$$\%\ yield = \frac{extract\ weight}{raw\ material\ weight} \times 100\%$$

$$\%\ yield = \frac{20.579\ g}{30\ g} \times 100\%$$

$$\%\ yield = 68.59\ \%$$

Phytochemical screening in this study aims to determine the class of compounds contained in frankincense gum ethanol extract originating from the Parsoburan area. The phytochemical screening results of frankincense gum ethanol extract obtained in this study showed that alkaloids, flavonoids, tannins, gumonins, and terpenoids could be attracted to ethanol solvents.

In phytochemical screening, the principle used in alkaloid tests is a settling reaction that occurs due to ligand replacement. Nitrogen atoms that have free electron pairs on alkaloids can replace iodine ions in dragendroff reagents [7]. In this test, there was a brick-red precipitate formed after the addition of dragendroff reagents. In the flavonoid test, the addition of $FeCl_3$ 5% caused a greenish-black color, which indicates the presence of flavonoids. Meanwhile, in the tannin test, $FeCl_3$ 1% material resulted in hydrolyzed tannins producing a blackish-green color indicating the

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presence of tannins. This color change occurs when the addition of $FeCl_3$ which reacts with one of the hydroxyl groups present in tannin compounds [15]. Gumonins are surface active compounds and can cause froth when shaken in water. This happens because gumonins have polar and non-polar groups that will form micelles. When the micelle is formed, the polar group will face outwards and the nonpolar group faces inward and this state looks like foam [16]. In this test, there was foam after shaking. The addition of glacial acetic acid and concentrated sulfuric acid to the ethanol extract of incense gum will cause an orange or purple color, but in the test a blackish brown color appears which indicates the absence of terpenoids. The results of the phytochemical screening test of frankincense resin can be seen in the following table:

Table 1. Phytochemical screening results

Secondary metabolites	Reagents	Result	Explanation
Alkaloids	Dragendorf	+	The brick red precipitate is formed
Flavonoids	$FeCl_3$ 5%	+	Creates a brownish red color
Tannins	Aquadest and HCl	+	Creates a blackish green color
Gumonins	$FeCl_3$ 1%	+	Presence of foam after shaking
Terpenoids	CH_3COOH	-	Creates a blackish brown color



(a) (b) (c) (d) (e)

Figure 2. Phytochemical screening image of frankincense gum ethanol extract: (a) alkaloids, (b) flavanoids, (c) tannins, (d) gumonins, and (e) terpenoids

Based on previous research, [7] identified the presence of alkaloid compounds, flavonoids, gumonins, tannins, and terpenoids in frankincense gum extracts extracted using maceration and ethanol solvents. Thus, the phytochemical screening results obtained in this study are in accordance with the results obtained in previous studies.

Increased stability in the extract using cosolvent techniques. The viscous extract obtained will be given the addition of cosolvent. Cosolvency can reduce the hydrogen bonding density of water and create a less polar environment in the reservoir thereby reducing the chemical potential of the solution and allowing more drug molecules to enter the solution [17] This study used cosolvent propylene glycol, by mixing 5g of viscous extract of frankincense gum with 5 mL of propylene glycol 75%. Both are put into a glass beaker which is then stirred (150 rpm) using a magnetic stirrer. During stirring put 2 mL tween 80 as *solubilizing agent* slowly. Tween 80 has lipophilous properties so it can mix with oil. The structure of Tween 80 greatly affects the increase in the penetration of the preparation. Tween 80 has ethylene oxide and a long hydrocarbon chain. The structure provides lipophilic and hydrophilic characteristics, thus allowing partitioning between lipophilic compounds and hydrophilic proteins. Stirring at the stage of increased stability is carried out for 2 hours. This is done for the process of homogenization of the mixture of such

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solutions. After stirring for 2 hours, filtering is carried out to obtain the results of adding cosolvent in the form of pure viscous liquid. This test produced a pure viscous liquid of brownish-red color.



(a) (b)

Figure 3. (a) The process of stirring ethanol extract of frankincense gum with cosolvent, (b) The result of the addition of cosolvent.

The pH test is carried out using a pH meter which aims to determine the nature of the sample in irritating the skin. Acidic preparations can cause irritation to the skin, while preparations that are too alkaline can result in scaly skin [18]. The use of a pH meter by dipping it into the ethanol extract of incense gum so that the pH value is read. The use of a pH meter was chosen because the measurement results are more accurate and faster. The pH measurement results of the frankincense gum ethanol extract test sample after the addition of cosolvent, namely at pH 4.8. The pH test results obtained are different from the pH of the reference sample used as a comparison, which is 4.7.

The viscosity test is very important to test because it is closely related to the physical properties of the preparation such as stability, dispersion and adhesion. Viscosity describes the viscosity of the preparation. The more diluted or soft the preparation, the easier it will be applied and spread on the surface of the skin. Viscosity testing of frankincense gum ethanol extract after addition of cosolvent using Ostwald viscometer. Based on the viscosity calculation, the viscosity of frankincense gum ethanol extract was obtained with the addition of 75% propylene glycol and tween 80, which is 67,245 centipoises. In contrast to the viscosity of the reference sample used as a comparison sample, it is 44,455 centipoises. The viscosity of the reference sample has a lower viscosity than the viscosity of frankincense gum ethanol extract with the addition of cosolvent. The inherent power of a preparation is directly proportional to viscosity. The higher the viscosity of a preparation, the higher its adhesion. However, the higher the viscosity and adhesion of a preparation, the lower the dispersal power.

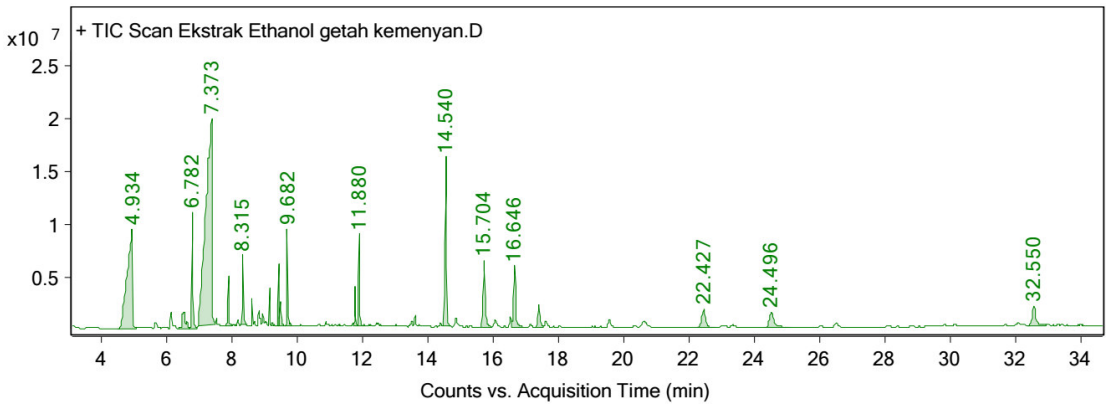


Figure 4. Chromatogram of the results of the GC-MS test analysis of frankincense gum ethanol extract.

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The principle of GC-MS is the separation of the components in the mixture with gas chromatography and each component can be made a mass spectrum with higher accuracy. The result of separation with gas chromatography is produced chromatogram while the results of mass spectrometry examination of each compound are called spectrum. The results obtained for frankincense gum ethanol extract are shown in Figure 4.

The results of the analysis of the chemical content of the constituent results of ethanol extraction of frankincense gum detected by GC-MS consist of several compounds with Retention Time (RT) and different percentage areas. The variety of compounds contained can be seen in the Table 2.

Table 3. The results of the GC-MS analysis of the chemical components of the ethanol extract of incense gum.

Peak	RT	% Area	Chemical components	Qual
1	4.934	41.62	Benzoic acid	99.21
2	6.782	11.95	Vanilla	97.79
3	7.373	100	2-Propenoic acid, 3-phenyl (cinnamic acid)	98.12
4	8.315	6.79	Phenol, 2-methoxy-4-(2-propenyl)	85.24
5	9.405	3.46	2-Propanone, 1-hydroxy-3-(4-hydroxy-3-methoxyphenyl)	94.33
6	9.682	7.46	Benzoic acid, phenylmethyl ester	93.83
7	11.880	6.68	2-Propenoic acid, 3-phenyl-,phenylmethyl ester, (E)-	98.15
8	14.540	19.99	Cinnamyl cinnamate	99.04
9	15.704	11.64	3- (4-Hydroxy-3-methoxyphenyl)-2-oxoprolyl benzoate	89.50
10	16.646	9.83	Mandelic acid, 3,4-dimethoxy-, methyl ester	85.51

The percentage of area (area %) commonly called Area peak is a value to indicate the concentration content of compounds in the sample. Based on data from Table 3 the largest compound component of frankincense gum ethanol extract through the apex area (%) namely bezoic acid (41.62%) and cinnamic acid derivatives namely 3-phenyl-2-Propenoic acid (100%). If a comparison is made between frankincense gum ethanol extraction samples and reference sample preparations, there are 5 types of similar compounds contained, namely benzoic acid, vanillin, cinnamic acid, (Z)-Cinnamyl benzoate, 2-Propenoic acid, 3-phenyl-, (E)-, and Cinnamyl cinnamate. The preparation of reference samples in the compounds of cinamic acid (100%) and benzoic acid (14.01%) was used as a comparison (Susanti *et al*, 2021).

Conclusion

The results showed that the extract yield, pH, viscosity, and chemical content in the ethanol extract of frankincense gum were respectively 68.59%; 4.8; 67.245 cP and identified the content of benzoic acid (41.62%), cinnamic acid derivatives, namely 2-Propenoic acid, 3-phenyl (100%) in the soxhletation extraction treatment with ethanol solvent. This shows that the soxhletation method can be used to produce frankincense gum extract by retaining the active compounds contained in the extract.

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Optimalization of Phosphate Modified Bio-sorbent of Oil Palm Empty Fruit Bunches for Ammonia Removal

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Abstract. In this research we synthesized bio-sorbent from oil palm empty fruit bunches (OPEFB) then modified it with phosphoric acid to increase bio-sorbent sites active refer to P-OPEFB. The method was simple, easy and low cost. OPEFB bio-sorbent was modified by immersing the bio-sorbent with diluted phosphoric acid. The color of OPEFB bio-sorbent was changing after modified with phosphoric acid, from brown to be light brown. It indicated chemical reaction occurred on the bio-sorbent materials. Bio-sorbent was characterized by EDX. EDX analysis indicated the presence of P in the modified bio-sorbent and

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remove all the trace element (K, Ca, Mg) from bio-sorbent. The presence of P influenced the percentage of ammonia removal.
Keywords: (Bio-sorbent, Phosphate Modified Bio-sorbent, OPEFB)

Introduction

Oil palm empty fruit bunches (OPEFB) is by product of palm oil industry. In processing 1 ton of FFB (fresh fruit bunches) into CPO (crude palm oil), it derived 230 Kg of OPEFB [1]. Yanti, (2020) predicted total OPEFB production in 2028 reach 11 million ton[2]. This OPEFB consists of hemicellulose (28.93%), lignin (15.32%) and cellulose (55.75%) [1]. This component could be converted into value-added product, for example bio-sorbent [3], activated carbon [4], cellulose extract [5], and bioethanol[6,7].

Beside OPEFB, palm oil industry also produced a liquid waste, POME (palm oil mill effluent). POME is an oily and non-toxic liquid waste that is disposed of in open ponds. Zulkifli (2016) reports that for every production of 6.6 trillion kg of CPO, 16.5 trillion kg of POME is produced [8]. The content of POME varies depending on the process (method) while processing FFB into CPO [9]. POME contain ammonia-nitrogen in high concentration, in range 35 – 103 mg/L [10]. Most of POME followed the sewage treatment process before being discharge into environment. Nitrification occurred in this process, to convert ammonia-nitrogen into nitrate or nitrite nitrogen. Notwithstanding, some of ammonia-nitrogen may remained in the water (river) near the sewage treatment plant. [11]

In order to remove ammonia in the water, in this study, OPEFB converted into OPEFB bio-sorbent, then it modified by phosphoric acid to increase the sites active. The adsorption experiment did in batch system using ammonia in certain condition (adsorbent dosage, initial concentration and contact time).

Methodology

Preparation of OPEFB bio-sorbent

OPEFB were collected from Pagar Merbau PKS, Deli Serdang, North Sumatra. It cut into small pieces, cleaned under running water and dried in the sun. Then, dried OPEFB grinded, sieved under 200 mesh sieve and purified using distilled water. The result called as OPEFB bio-sorbent.

Modification of OPEFB bio-sorbents with phosphates

OPEFB bio-sorbent, added into 0.2 M H_3PO_4 with the ratio 1:100. Then, the mixture was stirred for 180 minutes at 60ºC. The mixture was filtered, the precipitate was dried in an oven at 120ºC for 3 hours. The result called as P-OPEFB bio-sorbent.

Characterization

OPEFB and P-OPEFB bio-sorbents were characterized using EDX for analyzing the elemental component.

Adsorption Experiments

OPEFB and P-OPEFB bio-sorbents were used to adsorb dissolve ammonia in the form of ammonium hydroxide. The certain amount (1; 2; 3; 4; and 5) g of bio-sorbents were immersed into ammonium hydroxide for certain time (30; 60; 90; 120; 150; 180 and 210) minutes with certain concentration (0,5; 0,75; 1; 1,25; 1,5; 1,75; 2; 2.25) M to find the optimum mass, concentration

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and contact time. In order to analyzed the ammonia that adsorbed into both bio-sorbent, volumetric method was applied by titrating the filtrate using HCl solution.

Results and Discussion

Preparation of OPEFB bio-sorbent from its solid waste was simple and easy process. It did not need any chemical solvent to produce OPEFB bio-sorbent. This description is completely compatible with the report of Daneshfozoun et al. [3]. The method was very green and the product could be used to remove ammonia from wastewater. It also confirm by the report of Nasir et al. [12]. Meanwhile, modification of OPEFB could increase the capabilities of OPEFB bio-sorbent to remove pollutant in the water especially ammonia. However, it needed solvent in the form of diluted phosphoric acid. The method was still simple, easy and low cost.

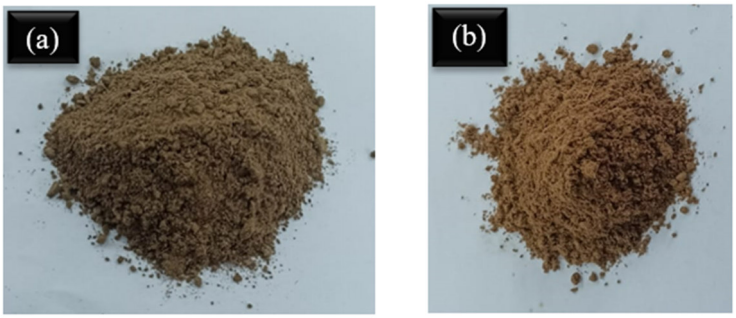


Figure 1. Appearance changes of bio-sorbent color (a) OPEFB and (b) P-OPEFB

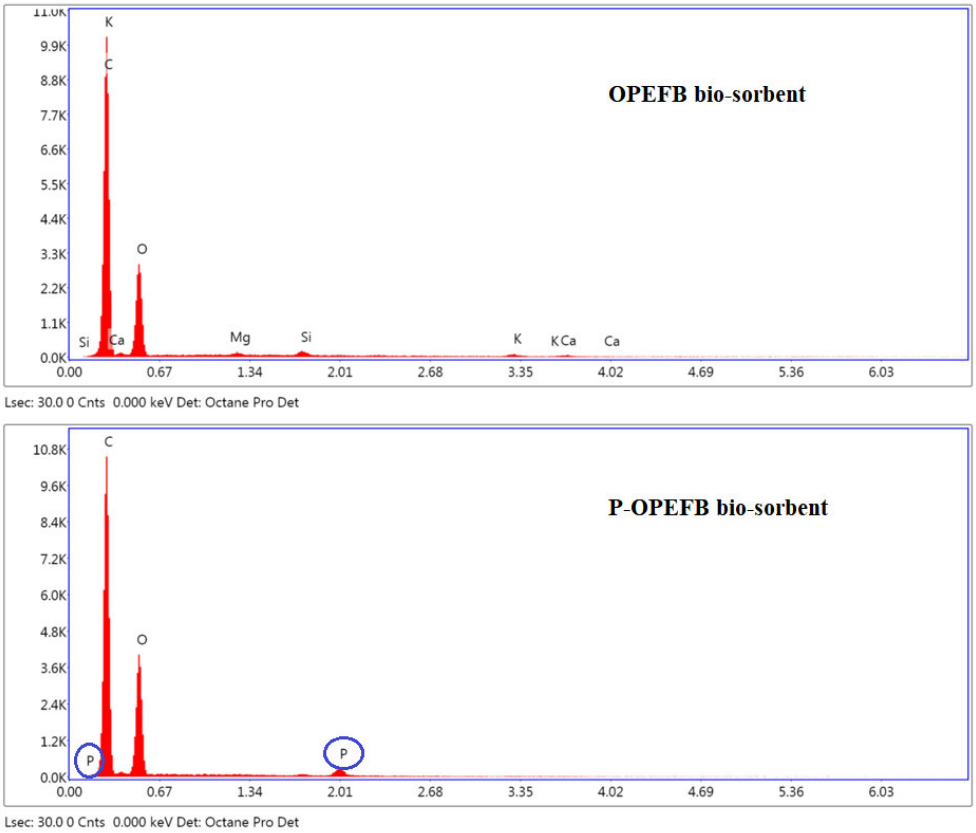


Figure 2. EDX analysis of OPEFB and P-OPEFB bio-sorbent

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After modification, the color of P-OPEFB turn from brown to be light brown (Figure 1) This change mainly was due to the reaction between phosphoric acid with cellulose, hemicellulose and lignin in OPEFB and it was confirmed by FTIR (results not shown). The presence of phosphor in the P-OPEFB bio-sorbent was analyzed using energy-dispersive X-ray (EDX). Figure 2. indicated that phosphor presence in the P-OPEFB. In addition, immersing the OPEFB bio-sorbent with phosphoric acid dissolved all the trace element (Mg, K and Ca) that found in the OPEFB bio-sorbent (Figure 2). [13]

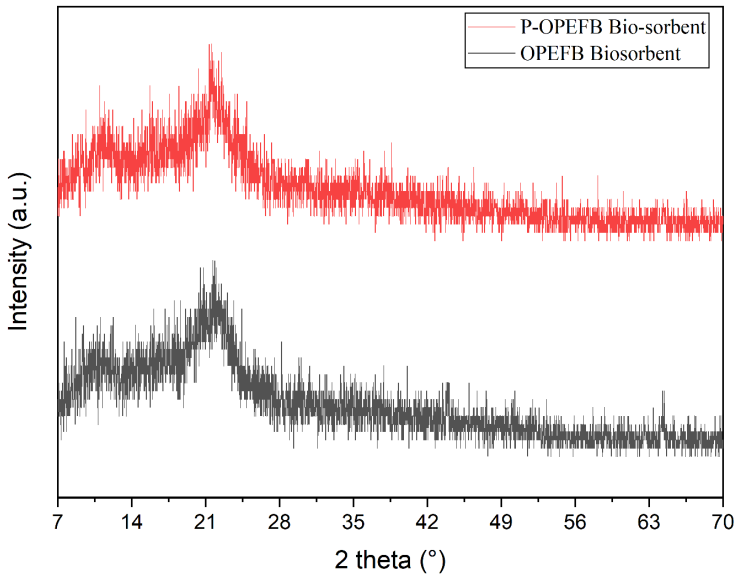


Figure 3. X-ray diffraction pattern for OPEFB and P-OPEFB bio-sorbent

Figure 3. presented the XRD patterns, exhibiting that both OPEFB and P-OPEFB bio-sorbent is amorphous. It confirmed by the report of Daneshfozoun et al. the amorphous part came from hemicellulose [14]. Further analysis using EXPO 2014 method, viewing that unit cell volume of OPEFB twofold of P-OPEFB, while both crystal system is triclinic. Presence of phosphor affected the unit cell volume of P-OPEFB bio-sorbent but did not affect the crystallinity of the bio-sorbent structure.

Table 1. Sample Parameter of OPEFB and P-OPEFB with EXPO 2014 Method

No	Sample	A (Å)	B (Å)	C(Å)	α(Å)	β(Å)	γ(Å)	Unit Cell Volume	Crystal System
1	OPEFB	14.7708	16.41130	10.6228	92.56417	105.80756	66.82462	2271.95	Triclinic
2	P-OPEFB	13.36290	14.90750	9.98381	93.56973	102.1573	144.8381	1071.97	Triclinic

The initial concentration of ammonia are potent to both adsorption capacity and efficiency[15]. The adsorption experiment carried out by immersing the same amount of bio-sorbent in the variation initial concentration of ammonia. This study influenced the adsorption efficiency Figure 4. This research employed 10 initial concentrations of ammonia, which were 0.25, 0.50, 0.75, 1.00, 1.25, 1.50, 1.75, 2.00, 2.25 and 2.50 M. According to Figure 4 the ammonia removal was fluctuated with increasing of initial concentration. At the first initial concentration

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0.25 M, the ammonium hydroxide was rapidly adsorbed with the efficiency 40% for OPEFB and 35% for P-OPEFB, then it fluctuated with the addition of initial concentration of ammonia. The highest efficiency of ammonia adsorption was 40.95 % with initial concentration 0.25 M for OPEFB and 40.20% with initial concentration 1.25 M for P-OPEFB. The ammonia removal depends on the nature of bio-sorbent. Ammonia is small molecule, its physical interaction with surface of bio-sorbent is expected to be weak. So chemical interaction is preferable due to its strong affinity [16].

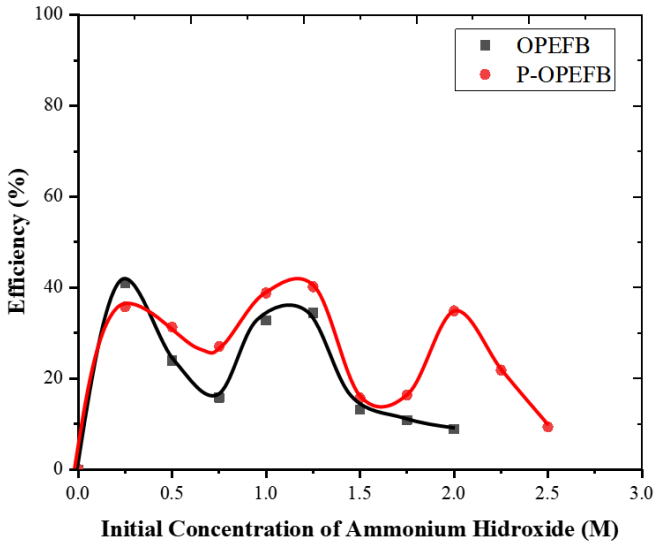


Figure 3. Effect of initial concentration of ammonium hydroxide of onto OPEFB and P-OPEFB bio-sorbent

Further study was the effect of contact time on the adsorption of dissolve ammonia on both OPEFB and P-OPEFB bio-sorbent (Figure 4). The result presented that increasing contact time was increasing the percentage removal of ammonia in OPEFB bio-sorbent then it reached maximum adsorption (efficiency 60%) within 180 min. Meanwhile, the P-OPEFB shown different phenomena, at the first 30 min the ammonium hydroxide adsorbed as much as 42% then it decreased gradually till 90 min and continue increase gradually till reached the maximum adsorption (efficiency 66%) within 150 min. Nevertheless, the percentage of removal ammonia by P-OPEFB was higher than OPEFB. It also proved that the phosphoric acid modification affected the ability of bio-sorbent to adsorb ammonia [17]. The unique ammonia adsorption shown by P-OPEFB which indicated saturated adsorb after 30 minutes then gradually increase after 90 minutes. It suggest the first phase increasing adsorption due to the increasing surface area than OPEFB, then after 90 minutes interaction of P with ammonia induce the increasing of adsorption amount.

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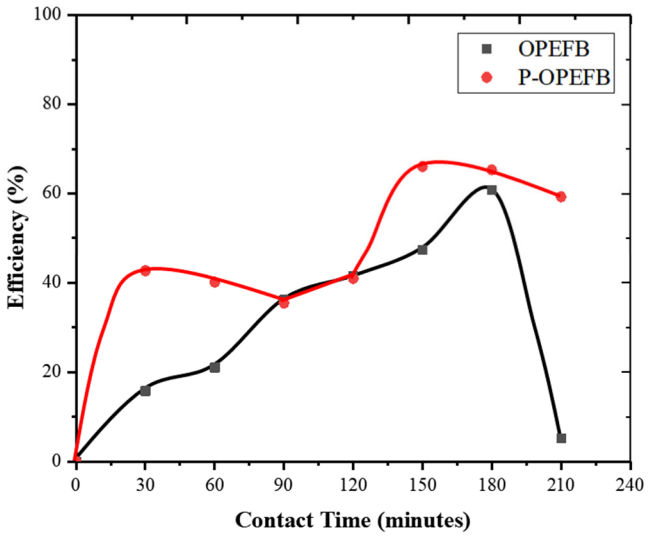


Figure 4. Effect of contact time of ammonium hydroxide of onto OPEFB and P-OPEFB bio-sorbent

Conclusion

The ability of OPEFB and P-OPEFB bio-sorbent in removing ammonia offered a promising treatment for water contamination and for decreasing ammonia content in the POME wastewater. The method to converting OPEFB waste to be OPEFB and P-OPEFB bio-sorbent was simple, easy, and low cost. The modification of OPEFB using phosphoric acid changed the color of bio-sorbent, brown to be light brown, and removed all the trace element (K, Ca, Mg) in bio-sorbent. EDX analysis showed the presence of P element in the P-OPEFB bio-sorbent which was influence the percentage removal of ammonia

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Synthesis and characterization of derived oil palm empty fruit bunches activated carbon with alginate and Fe

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Abstract. *In this research we synthesized of activated carbon from oil palm empty fruit bunches (OPEFB) then combined it with alginate then crosslinked by Fe^{3+} ion to form activated carbon/alginate-Fe composite in the form of beads. The beads composites was characterized by FTIR and BET. In addition, the slow release of Fe^{3+} was studied by kinetic test using AAS. The carbonyl and hydroxyl of activated carbon/alginate-Fe appeared in FTIR spectra hence confirming the successful of activated carbon/alginate-Fe preparation. The BET analysis found the composite has surface area about 24.914 m^2/g, pore volume 0.032 cm^3/g and the average pore size diameter 10.424 nm. Therefore, the composite*

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was in mesophorus structure. The kinetic test was carried out using AAS during 3 days contact time. The release of Fe^{3+} from activated carbon/alginate-Fe composite was followed pseudo-second order kinetic.

Keywords: activated carbon, alginate, composites, slow release

Introduction

Fertilizers are necessary for agrochemicals which provide important micronutrients. These micronutrient play an important role to protect the plant to the root as well. However, the nutrient from conventional fertilizer generates environmental pollution due to release directly in the soil. This phenomenon affects nutrient deficiency in plants. To prevent and overcome this situation, slow-release fertilizers are recently used. Slow-release fertilizers is an effective way for developing fertilizer concentration, reduce the loss of nutrients as well as contribute to steady crop growth. In addition, slow released fertilizer are able to reduce frequency of fertilization, leaching and degradation, hence, developing suistainable agriculture.[1-2]. Several studies had been developed to obtain slow release fertilizer using various materials. The characteristic of these material fertilizer attracts attention some researchers to develop a low cost materials, non-toxic and biocompatibility such as carbon based materials, polymers and polysaccharides [3−5]. Prastiwi et al prepared an activated carbon as micronutrients carrier in slow release fertilizer. Shen et al studied double-network hydrogels based on sodium alginate and halloysite for slow release fertilizers.

Activated carbon is a porous material that widely used in variety of areas including adsorption, catalysis and electrochemical application due to its specifically high surface area, porosity, chemical inertness and good thermal stability [6-7]. Natural product contain high carbon, thus producing abundant of activated carbon. The commercialized activated carbon will proceed high-cost materials [8]. Therefore, our group previous work had succesfully sinthesized the activated carbon from oil palm empty fruit bunches (OPEFB) as bioadsorbent. It generates the activated carbon has more homogenous and smoother surface. As one of the largest oil palm producers, the solid waste of OPEFB is widely found. Thus, the modification of OPEFB as removal pollutant is continuously developed [9]. Some researchers modify the activated carbon with biopolymers such as chitosan and alginate as an adsorption alternative [10-13].

Commercially, alginate is obtainable as sodium salt alginic acid (NaAlg) which is a natural polysaccharide. This polysaccharide is composed of α -L-guluronic acid (G) and the β-D-mannuronic acid (M) and extracted from brown seaweeds [14-15]. Alginate is also an anionic polysaccharide that widely used in biofabrication or encapsulation [16-20]. The sodium alginate is a nontoxic, stable in environtment as well as biodegradable [21-22]. Alginate has good ability to form gelation or film due to its high bicompatibilty to establish a combination with multivalent ion [23].

As the polymer with a large quantities of free hydroxyl and carboxyl groups allocated along the backbone chain of the polymer, alginate has a large surface functional group to generate a modification by chemical crosslinking such as divalent ion. Hence, a water-insoluble gel with a characteristic “egg-box” structure is formed [24]. However, alginate possesses very slow degradability and uncontrolled degradation kinetics [25-27]. On the other hand, divalent ion, for example Ca^{2+}, will form calcium alginate gel beads with poor mechanical strength [28]. Based on previous studies, a trivalent metal ion, Fe^{3+}, may be promising crossinking agent to improve the mechanical properties. The physical interaction between Fe^{3+} and carboxyl group will increase the strength of alginate beads and decrease its solubility [15]. These composites were characterized by Fourier transform infrared (FTIR) spectroscopy and BET. Hence, this study will conduct the iron

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cross linked composite for preliminary study of slow release fertilizer to be applied on future agriculture.

Methodology

Activated Carbon Preparation

Oil palm empty fruit bunches (OPEFB) were collected from Binjai and Deli Serdang, North Sumatera. The OPEFBs were prepared from previous work [9]. The OPEFB were carbonized at 400ºC for 3 minutes using furnace to remove impurities and non-carbon material. Further, the carbon was immersed in 10% of phospat acid for 24 hours to form activated carbon. Subsequently, the activated carbon will filtered and washed using distilled water until neutral pH. Then dried in an oven at 105 ºC for 24 hours.

Activated carbon/Alginate-Fe composite preparation

In a flask, activated carbon and sodium alginate (1:1) were dissolved in 100 ml of distilled water and stirred until completely dissolved. Further, the solution was dripped slowly into 0.1 M of $FeCl_3$ solution to form beads composite. The composite was stopped stirring and left for 24 hours to produces a complete crosslinking. Later, the composite was washed until neutral pH using distilled water and dried in oven. The illustration of composite preparation can be seen in figure 1. The activated carbon/alginate-Fe composite was characterized using fourier transform infrared (FTIR) and Brunauer-Emmett-Teller (BET).

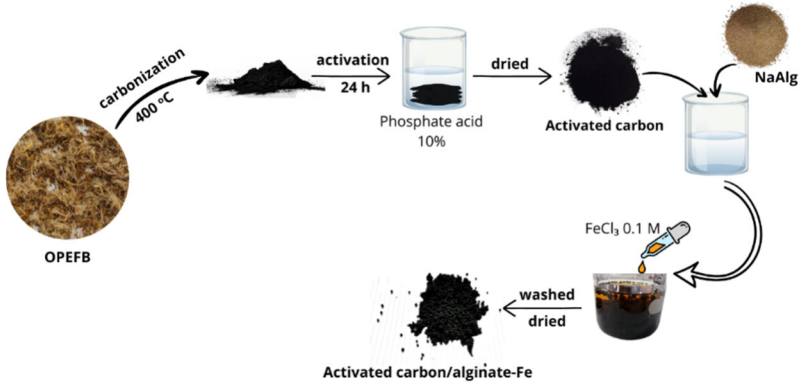


Figure 1. The scheme of activated carbon/alginated-Fe preparation

Slow release kinectic test

About 0.05 g of activated carbon/alginate-Fe was immersed in 0.33 M of citric acid to remove Fe^{3+} with variety of time at 5, 15, 30, 60 minutes, 1 day and 3 days. Later on, the mixture was filtrated and analyzed using atomic absorption spectroscopy (AAS).

Results and discussion

Characterization of activated carbon/alginate-Fe composite

FTIR spectra of activated carbon/Alginate-Fe composite was carried out to prove the formation of a blend polymer matrix structure. The FTIR spectra of alginate and activated carbon/alginate-Fe are illustrated in figure 2. The alginate spectra showed the bands at 3244.19 cm^{-1}, 2886.5cm^{-1}, 1584.06 cm^{-1}, 1412.44 cm^{-1} and 1052.56 which are attributed to –OH group, asymmetric stretch

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of -CH_2, asymmetric-symmetric stretch of carboxyl group, and C-O-C stretching vibration, respectively.

FTIR spectrum of activated carbon/Alginate-Fe appearing around 3330.74 cm^{-1}, 1598.00 cm^{-1}, 1417.20 cm^{-1} and 1056.72 cm^{-1} corresponded to vibrational bands of –OH, the asymmetric and symmetric stretching vibration of COO- group, and asymmetric COC- stretching vibration, respectively. The –OH stretching band of the activated carbon/alginate-Fe is shifted to higher wavenumber as well as higher intensity. This shifting is affected by intermolecular bond formation which leads adjacent hydroxyl groups and indicated as the proceed of alginate beads' conformational by reacting with activated carbon and Fe^{3+} ion. The carboxyl appears to confirm the activated carbon presence in composite and shift to the higher wavenumber. The carboxyl characteristic bands of 1598.00 cm^{-1} and 1417.20 cm^{-1} are shifted to the higher wavenumber compare to alginate structure. The shift probably occurs due to the replacement of Fe^{3+} in the sodium alginate during crosslinking process [28-29].

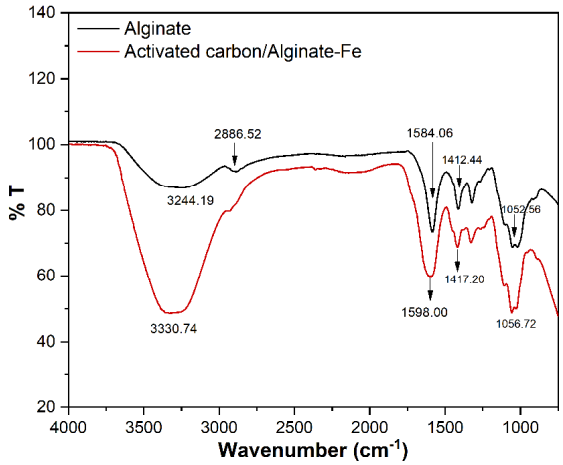


Figure 2. FTIR spectra of alginate and activated carbon/alginate-Fe composite

The composite's surface area, pore volume and pore diameter were determined by BET method based on nitrogen adsorption. As illustrated in figure 3a, the obvious hysteresis loop obtained from the graph indicates the type IV isotherm according to IUPAC classification [30-32], thus the composite is mesoporous with surface area 24.914 m^2/g. The pore volume is about 0.032 cm^3/g.

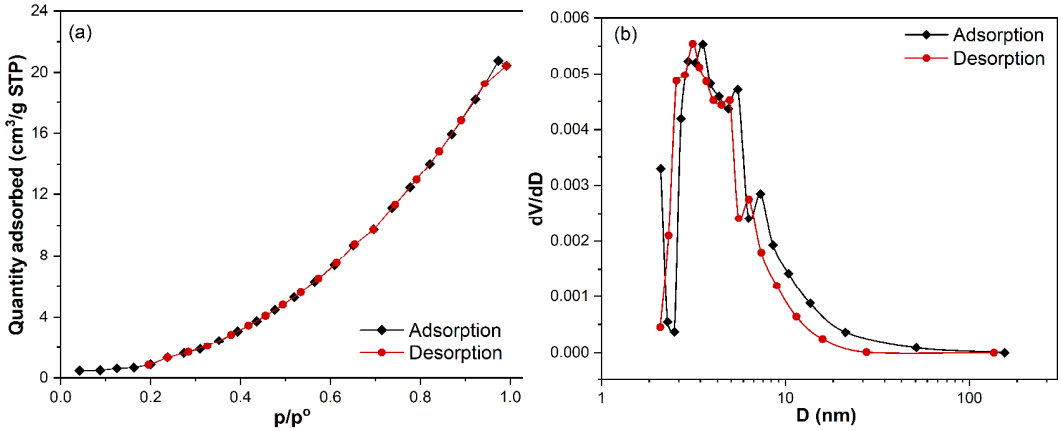


Figure 3. (a) N_2 adsorption-desorption curve and (b) pore size distribution of activated carbon/alginate-Fe

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Based on distribution of pore size in figure 3b, the average pore size diameter of the composite is 10.424 nm. This size distribution is above 2 nm which defined as mesoporous in structure. Benhouria et al [33-35] and Nasrulla et al [36,37] also reported the activated carbon-alginate modified composite in mesoporous structure.

Slow release test of activated carbon/alginate-Fe composite

The kinetic study was carried out by varying the contact time from 5 minutes to 4320 minutes (3 days). As depicted in figure 4, the concentration of Fe tends to decrease significantly until 60 minutes. After incubation in 60 minutes, the concentration of Fe in composite tends to be constant until the 1440 minutes (1 day) and decrease notably in the next 3 days. Contrary, the release of Fe^{3+} from composite is increased during period of time. In summary, Fe^{3+} is slow-released from activated carbon/alginate-Fe composite in citric acid solution during 3 days incubation.

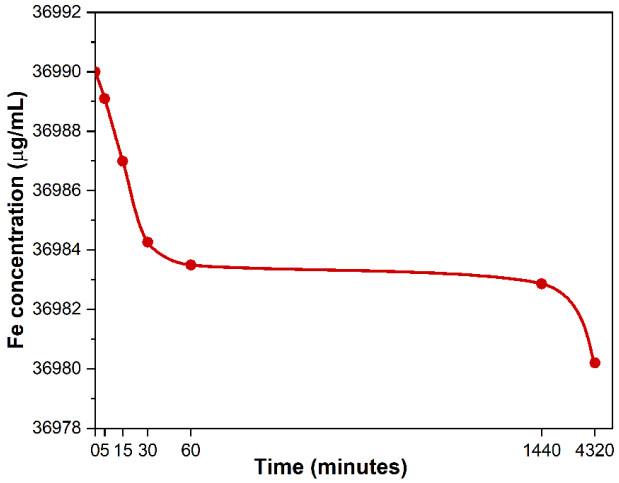


Figure 4. Fe concentration in activated carbon/alginate-Fe after releasing Fe^{3+}

The release of Fe^{3+} from activated carbon/alginate-Fe composites was reviewed by considering several kinetic models such as zero model, pseudo-first order, pseudo-second order and Korsmeyer-Peppas model. Pseudo-second order gave the best fit for Fe^{3+} release from activated carbon/alginate-Fe composite with $R^2 = 0.9866$. Thus, it can be concluded the release of Fe^{3+} occurs in many reaction steps such as releasing from surface and inside the composite as well [3].

Conclusion

A preliminary study of activated carbon/alginate-Fe composite was prepared and analyzed the slow release of Fe^{3+}. The composite was well synthesized and confirmed by the FTIR characterization. The activated carbon/alginate-Fe was in mesophorus structure with average pore size diameter 10.424 nm and surface area about 24.914 m^2/g. In terms of short contact time, the Fe^{3+} was removed slowy from the composite. Thus, based on the kinetic test the activated carbon/alginate-Fe was proper to become slow release fertilizer during 3 days contact time. In addition, the composite was followed the pseudo-second order kinetic.

Acknowledgement

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Analysis of Fe metal adsorption in well water using natural biosorbent from corn leaves waste

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Abstract. *Weighty metals are for the most part harmful for living things, yet some of them are required and modest quantities. Weighty metals enter the climate through different mediators, like debased air, food, and water. Risky weighty metals that frequently contaminate the climate incorporate mercury (Hg), iron (Fe), lead (Pb), arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), and nickel (Ni). These weighty metals are known to gather in the body of a living being and stay for quite a while as poisons. The adsorption cycle is more reasonable on the grounds that the expenses required are not excessively costly and won't cause new pollutants. Right now, research is being advanced on the utilization of elective adsorbents got from nature. Normal adsorbents as well as having great adsorption capacity, are additionally more conservative. Thusly, this study was directed to break down the substance of Fe metal in well water utilizing a characteristic adsorbent got from corn leaves (Zea mays) squander and to look at the consequences of the adsorption force of Fe metal utilizing a characteristic adsorbent from corn leaves squander. To accomplish this objective, the exploration strategy that will be completed is the Atomic Absorption Spectrophotometric (AAS) technique. Absorbance was estimated in well water tests that had been added with normal adsorbent from corn leaves (Zea mays) squander. The worth of the straight relapse condition for standard Fe is gotten $y = 0.0053x + 0.0027$ with $R^2 = 0.9958$, it is expressed that there is linearity among focus and absorbance. The direct relapse condition was utilized to decide the centralization of Fe metal in well water tests both when adding the adsorbent. The outcomes showed that corn leaves carbon enacted with sulfuric corrosive has the ideal condition was at a mass of 1 gram to adsorb Fe(II)*

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metal with limit adsorption was 1.4285 mg.g^{-1} and adsorption percent was 99.62%. The underlying grouping of Fe(II) in well water acquired was 14.338 ppm, subsequent to adding activated carbon from corn leaves diminished the convergence of Fe(II) got was 0.0532 ppm. The capacity of actuated carbon from corn passes on adsorbent to retain Fe(II) in well water was 14.284 ppm.

Keywords: *normal adsorbent, corn leaves, carbon activated, adsorption, Atomic Absorption Spectrophotometry (AAS)*

Introduction

Ferrous metal is a type of heavy metal pollutant that is often found in water. The source of excess iron metal pollutants in the water is caused by the entry of industrial waste into the waters. Even though iron is an essential mineral, the presence of excess iron in the air can have an impact on public health which endangers the digestive system and skin, so the World Health Organization, namely WHO (World Health Organization) limits 0.3 mg/L of iron in the air. . drinking. [1] The presence of high heavy metals in waters can reduce water quality and endanger the environment and aquatic organisms. Several methods that can be used to reduce the concentration of metal ions in wastewater include precipitation, ion exchange using resins, filtration, and adsorption. Adsorption is the most commonly used method because it has a simpler concept and is also economical. The most important adsorption process is the adsorbent.[2] Types of materials that are often used as adsorbents include activated carbon, zeolite, and polymers. In addition, one type of adsorbent that is often used is cellulose.

Cellulose is a renewable natural biopolymer that is easily biodegradable and non-toxic. In plants, cellulose exists together with lignocellulose, hemicellulose, and lignin. One of the applications of lignocellulosic is as an adsorbent for wastewater treatment. Various sources of cellulose are used as adsorbents, namely: fiber, leaves, roots, shells, bark, husks, stems, and seeds.[3] In addition, corn leaves can be used as an adsorbent. In general, corn consists of 12% corn husk, 28% seeds, 17% cobs, 13% leaves, and 30% stems.[4] In dry corn leaves contain 10-20% cellulose. [5] With the cellulose content found in corn leaves, it has the potential to be used as a source of adsorbent. To deal with the above problems, research was carried out by utilizing waste natural materials as biosorbents to adsorb Fe heavy metals contained in water using corn leaves waste as adsorbents using Atomic Absorption Spectrophotometry (AAS) method.

Methodology

Materials

The AAS (Atomic Absorption Spectrophotometer), analytical balance, shaker, desiccator, magnetic stirrer, Whatman No. 42 filter paper, spray bottle, dropper, beaker, pH meter, funnel, flasks of 25 milliliters, 50 milliliters, and 100 milliliters, and watch glass are the instruments used in this study. Well water samples, corn leaves, aqua dest, H_2SO_4, HNO_3, a standard solution containing 1000 mg/L of Fe, an acetate buffer solution with a pH of 3.5, and acetone were all used in this study.

Adsorbents characterization

The structured adsorbent of corn leaves was identified through XRD analysis, and the surface area was measured through BET analysis.

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Well water sample preparation

After that, concentrated HNO_3 is added to the well water sample until a pH meter is used to measure pH 2. The sample was then placed in a bottle made of polyethylene that was filtered using Whatman filter paper No. 42 on a filter funnel to eliminate mud and sand from the sample. The sample can now be analyzed.. [7]

Analysis of Fe metal in well water using Atomic Absorption Spectrophotometer (AAS)

The absorbance of the standard solution that has been prepared with a concentration variation of 0.0; 0.5; 1.0; 5; 10; and 20 ppm, then the absorbance of the sample was measured at the maximum wavelength that had been obtained. The absorbance value of the measurement results was plotted against the concentration of the Fe standard solution to create a calibration curve. The absorbance of well water was measured by taking a sample of 25 mL of water, and the absorbance of the sample was measured at the maximum wavelength that had been obtained. The absorbance value of the measurement results was plotted against the concentration of the Fe standard solution.

Analysis of Fe metal in well water with added adsorbent of corn leaves using Atomic Absorption Spectrophotometer (AAS)

The absorbance of the standard solution that has been prepared with a concentration variation of 0.0; 0.5; 1.0; 5; 10; and 20 ppm, then the sample of well water added with adsorbent of corn leaves as a result of carbonization and activation, the absorbance of the sample and the standard solutions were measured at the maximum wavelength that had been obtained. The absorbance value of the measurement results was plotted against the concentration of the Fe standard solution to create a calibration curve. The absorbance of well water was measured by taking a sample of 25 mL of water, and the absorbance of the sample was measured at the maximum wavelength that had been obtained. The absorbance value of the measurement results was plotted against the concentration of the Fe standard solution.

Results and discussions

XRD characterization for adsorbents of corn leaves activated carbon

The results of XRD characterization can be seen in figure 1. The crystallinity of the layer that was formed on the adsorbent-activated carbon of corn leaves was determined by XRD characterization.

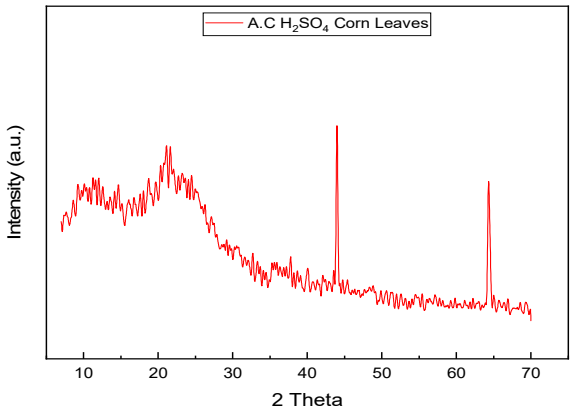


Figure 1. XRD pattern diffractogram of corn leaves carbon activated

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BET Characterization for adsorbents of corn leaves

The BET adsorption-desorption test of N_2 gas can be used to analyze surface area, pore volume, average pore size, and pore type.[8] Table 1 shows the BET Characterization Analysis for activated carbon from corn leaves and carbon from corn leaves.

Table 1. BET Characterization analysis result for corn leaves carbon and corn leaves activated carbon

No.	Analysis Result		Corn Leaves Carbon	Corn Leaves Activated Carbon
1.	Surface Area	BET (m^2/g)	83.834	45.597
		BJH (m^2/g)	54.233	32.355
2.	Pore Volume (cm^3/g)		0.0888	0.0613
3.	Average Pore Size (nm)		2.3210	2.8786
4.	Pore Type		micropore	micropore

The results of the BET analysis are shown in table 1, namely, the surface area based on BET data on corn leaves carbon of 83,834 m^2/g, corn leaves carbon that has been activated is 45,597 m^2/g. For the surface area using BJH data, corn leaves carbon has a surface area of 54,233 m^2/g, and the surface area of corn leaves carbon which has been activated is 32,355 m^2/g. Pore volume describes the pore capacity in adsorbate absorption and pore diameter also plays a role in adsorbate absorption, where the larger the pore diameter, the greater the pore volume value of the adsorbent so that the absorption ability will be higher. The highest volume and pore diameter are found in activated carbon, namely, the pore volume is 0.0613 cm^3/g with a pore diameter of 2.8786 nm.

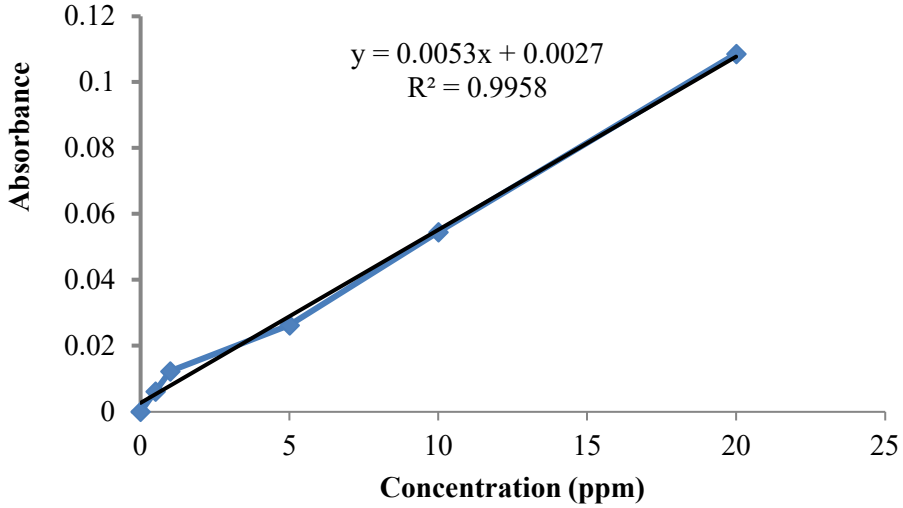


Figure 2. The calibration curve of the Fe standard solution

The Calibration Curve of the Fe Standard using an Atomic Absorption Spectrophotometer (AAS). The determination of the calibration curve is based on the results of absorbance measurements of Fe standard solutions with concentrations of 0.5 ppm, 1.0 ppm, 5.0 ppm, 10 ppm, and 20 ppm. The value of the linear regression equation is obtained as $y = 0.0053x + 0.0027$ with $R^2 = 0.9958$, it is stated that there is a linearity between concentration and absorbance. The

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linear regression equation was used to determine the concentration of Fe metal in well water samples both before and after adding the adsorbent. The calibration curve of the Fe standard solution can be seen in Figure 2.

Adsorbent optimum mass against fe metal adsorption

To determine the optimum mass of the adsorbent in the adsorption of Fe metal by activated carbon of corn leaves, a mass variation test was carried out. In this study using mass variations, namely 1 gram, 2 grams, 3 grams, 4 grams, and 5 grams, each mass was added to 100 mL of the water sample, then stirred and allowed to stand for 15 minutes.[9] The solution was filtered and a filtrate was obtained which would then be analyzed by Atomic Absorption Spectrophotometry (AAS). The adsorption process on activated carbon can be seen in Figure 3.

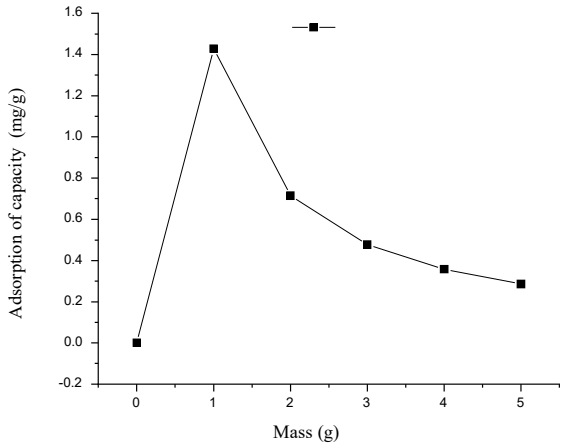


Figure 3. Mass variation adsorbent activated carbon of corn leaves adsorption of capacity

Based on figure 3, the graph above shows the relationship between the mass of the adsorbent and the absorption capacity of Fe metal. As the mass of the adsorbent increases, the absorption capacity decreases. This is because the surface of the adsorbent has reached a saturation point which results in a decrease in the adsorption capacity of the adsorbent. Based on the graphic data above, the optimum mass of the four activated carbons is 1 gram.

Activated carbon adsorption of well water samples

The treatment of using AAS analysis to examine the levels of Fe concentrations found in well water samples was carried out in this study. After that, one gram of activated carbon corn leaves was added to 100 milliliters of water samples. The linear regression equation $y = 0.0053x + 0.0027$, where the absorbance value of the water sample was 0.1131, was used to calculate the initial Fe concentration in the well water sample, which was 14.338 ppm. After adding activated carbon made from corn leaves, the result was a Fe concentration of 0.0532 ppm and an absorbance value of 0.00295 for the iron. In well water, activated carbon from corn leaves adsorbent was able to absorb 14.284 ppm of Fe(II).

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Conclusion

The value of the linear regression equation for standard Fe is obtained y = 0.0053x + 0.0027 with R^2 = 0.9958, it is stated that there is a linearity between concentration and absorbance. The linear regression equation was used to determine the concentration of Fe metal in well water samples both before and after adding the adsorbent. The results showed that corn leaves carbon activated with sulfuric acid has the optimum condition was at a mass of 1 gram to adsorb Fe(II) metal with capacity adsorption was 1.4285 $mg.g^{-1}$ and adsorption percent was 99.62%. The initial concentration of Fe(II) in well water obtained was 14.338 ppm, after adding activated carbon from corn leaves decreased the concentration of Fe(II) obtained was 0.0532 ppm. The ability of activated carbon from corn leaves adsorbent to absorb Fe(II) in well water was 14.284 ppm.

Acknowledgments

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Biodegradation of polyblend plastic films polystyrene with poly(δ-valerolactone) obtained from synthesis on landfill soil media

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Abstract. *In recent years, the accumulation of plastic waste has attracted the attention of a lot of researchers. The properties of the plastic being soluble in hydrophobic solvents makes it difficult to degrade in nature. As a result, plastic pollutes land, water and air. The aim of this study is to conduct biodegradation tests on polyblend polystyrene/poly(δ-valerolactone) (PS/PVL) and pure PS so that the waste problem*

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caused by plastic waste can be overcome. The one method that can be done so that PS plastic can be degraded is to mix it with a biodegradable polymer like PVL. The PVL used was obtained from the polymerization reaction of δ-valerolactone (VL) monomer with a Zirconium bis(β-diketonate) catalyst. The mixing method of PS with PVL is done by solvent casting. Then, the polyblend obtained was tested for biodegradation using landfill soil from the Universitas Negeri Medan. The results of the biodegradation test showed that the PS/PVL polyblend was biodegraded by 2.97%. while pure PS is 2.76%. At the final step, the water swelling test was also carried out on PS/PVL polyblend and pure PS.

Keywords: Biodegradation, landfill soil, polystyrene, poly(δ-valerolactone), polyblend

Introduction

Nowadays, the use of plastic for food and beverage packaging is very large. The properties of plastics that are flexible, economical, strong, thermoplastic, transparent, lightweight, non-corrosive, and not easy to decompose make them the main choice for use as packaging materials. In addition, the hydrophobic properties of the plastic can be an excellent barrier to oxygen, water vapor, and carbon dioxide. But because of its advantages, plastic also causes many problems, such as plastic waste that accumulates. As a result, there is pollution on land, sea, and air [1,2].

Polystyrene (PS) is one type of plastic that is also widely used and is hydrophobic. PS is a synthetic polymer with a high molecular weight and belongs to the group of thermoplastic polymers. At room temperature, PS is usually a solid thermoplastic and can melt when heated to high temperatures. PS is a recyclable polymer but difficult to decompose [3]. Currently, PS is widely used in electronic products such as casings and other electronic components. In addition, PS is also widely used for household needs such as brooms, combs, basins, hangers, biomedical materials, and buckets [4,5].

The one way to overcome the accumulated waste due to PS waste can be done by forming a polyblend. In the polyblend, PS will be mixed with a biodegradable polymer like polylactone [6,7] or with other natural materials [8,9]. PVL is one of the types of polylactones which has hydrophilic properties and will more easily interact with microbes compared to PS which has hydrophobic properties [7,10]. The PS/PVL polyblend biodegradation process will start from the chemical degradation step, which is the molecular oxidation process that produces polymers with low molecular weight such as oligomers. The next process is the attack of microorganisms such as bacteria, fungi, and algae. During this stage, enzymatic activities like intracellular and extracellular ones take place. In the final stages, monomers, carbon dioxide and water will be produced. Microorganisms that can normally degrade plastic include photosynthetic bacteria, endospore-forming, and aerobic bacteria [11,12].

Previously, our research group had conducted a biodegradation test for LDPE/PCL polyblend on landfill soil media. As a result, LDPE/PCL polyblend degrades faster than pure LDPE. In addition, we have also tested the biodegradation of PS/PCL polyblend on *A. niger* mushroom media. As a result, PS/PCL polyblend was degraded faster than pure PS [2].

In this research, blending will be carried out to produce PS/PVL polyblend. The PVL used is the result of VL polymerization with Zirconium bis(β-diketonate) catalyst [2,7,13,14]. Furthermore, the purpose of this study was to test the biodegradation of PS/PVL polyblend and pure PS on landfill soil media so that the PS plastic can be decomposed.

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Methodology

The manufacturing of PS/PVL polyblend plastic specimen films

The PS/PVL polyblend plastic film used in this study was made with a ratio of 10/2. The PVL used was obtained from the polymerization results as we reported in the previous study[7]. After that, the mixture of PS and PVL was refluxed using xylene solvent. Next, the solvent was evaporated and the plastic specimen was printed according to ASTM D638 size [2,15].

Biodegradation test of PS/PVL polyblend

The biodegradation test of polyblend plastic specimens begins with sterilizing the work area. The PS/PVL polyblend plastic used is 3 x 3 cm^2 in size. The plastic is then soaked in 70% alcohol for 10 minutes. After that, it was rinsed using distilled water. The same procedure was carried out 3 times. After drying, it was weighed using an analytical balance. Next, the plastic is then buried in landfill soil and every 10 days it is sterilized again and weighed. The landfill soil used was obtained from the Universitas Negeri Medan landfill. Last, the biodegradation test was carried out for 60 days and the weight changes were observed using an analytical balance [2].

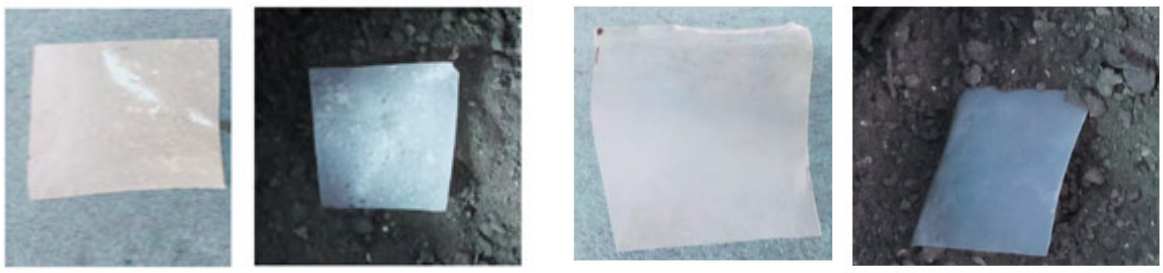
The water swelling test

The water swelling test carried out according to ASTM D 570; ISO-62 procedures. The water swelling test begins by cutting a 2x2 cm sample and weighed. After that, the sample was soaked and heated at 105 ^oC for 6 hours. When finished, the sample is cleaned and the final weight of the sample is calculated again [16,17]. Last, the weight measurement was carried out every 3 hours.

Results and discussion

Biodegradation test of PS/PVL polyblend using landfill soil media

The results of the biodegradation test for PS/PVL polyblend and pure PS in landfill soil media for 60 days are shown in Figure 1.



(a) **(b)** **(c)** **(d)**

Figure 1. Biodegradation test of PS/PVL polyblend and pure PS using landfill soil media (a) PS 0d, (b) PS 60d, (c) PS/PVL 0d, (d) PS/PVL 60d.

Figure 1 shows the difference between plastic specimens before and after degradation. After the 60th day, it was observed the presence of granules on the plastic surface. This condition indicates that there has been contact between microbes in the landfill soil with polyblend plastic.

Meanwhile, the rate of biodegradation of plastic specimens is shown in Table 1. Pure PS plastic and PS/PVL polyblend specimens underwent weight changes with different percentages. On the 20th day, pure PS weight percentage changed to 97.24% while PS/PVL polyblend was only

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99.01%. On the 40th day, the percentage of pure PS by weight remained 97.24% while the PS/PVL polyblend decreased significantly to 98.02%. Finally, on the 60th day, the pure PS weight percentage remained 97.24%. Meanwhile, PS/PVL polyblend also dropped significantly to 97.03%.

The biodegradation rate of PS/PVL polyblend is higher than that of pure PS as shown in Table 1 and Figure 2. In addition, PS/PVL polyblend can also gradually experience a significant decrease. Meanwhile, the degradation rate of pure PS looks constant because PS has a long carbon group and hydrophobic styrene. As a result, it will be difficult for microbes to interact in the long term with PS. In the long term, it is possible that there will be a faster rate of polyblend biodegradation compare pure PS. This is because the contact between microbes and polyblend plastic specimens is easier to sticky than pure PS [18].

Table 1. Residual weight percentage of PS/PVL polyblend after biodegradation process in landfill soil media

Day	**0**	**10**	**20**	**30**	**40**	**50**	**60**
% PS	100	98.62	97.24	97.24	97.24	97.24	97.24
% PS/PVL	100	99.01	99.01	98.51	98.02	97.52	97.03

The presence of the PVL carbonyl group in the polyblend with hydrophilic properties causes the oxidation process to occur more easily compare to PS. In the early stages, microbes will attach to the hydrophilic side of the PVL. After that, microbes will gradually break down PS/PVL polyblend into smaller molecules such as oligomers, CO_2, and H_2O. In addition, there will be more microbes attached to polyblend than pure PS so that the process of microbial secretion occurs more easily. As a result, bacteria and fungi present in landfill soil media will more easily depolymerize polyblend than in pure PS which is hydrophobic [2,18].

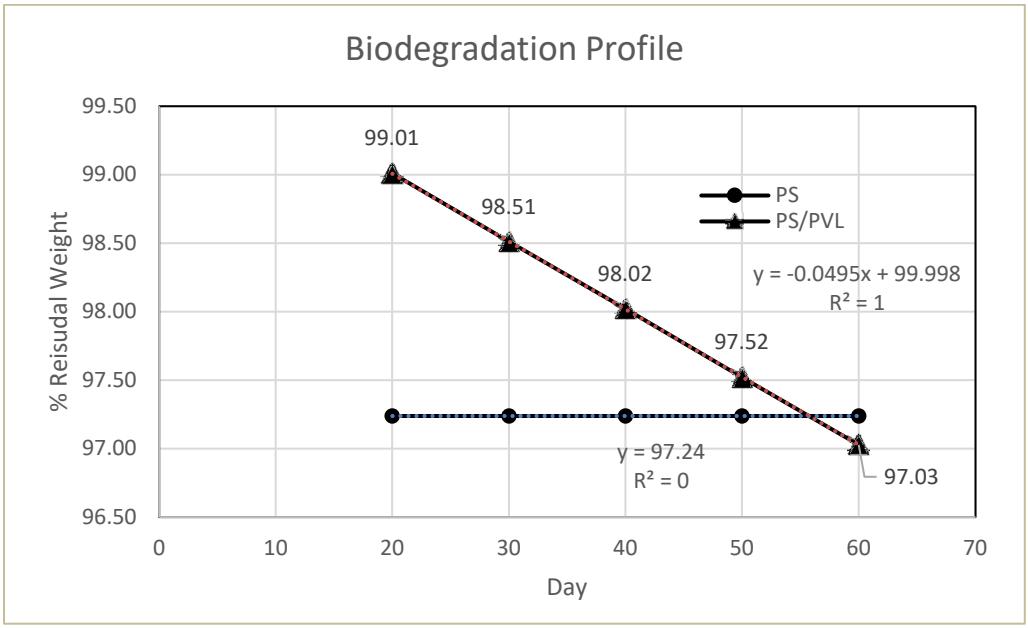


Figure 2. PS/PVL polyblend degradation rate on day 20 to 60

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Based on the regression line equation as shown in Figure 2 with a value of R^2=1, PS/PVL polyblend decomposition time can be modeled up to 95%. The time for the decomposition of PS/PVL polyblend to the remaining half (t50%) is 1,010 days. Furthermore, the decomposition time of PS/PVL polyblend to the remaining 5% (t95%) is 1,919 days as shown in Table 2 [19]. For 100% decomposition (t100%), no calculation modeling was carried out because the polymer could not completely decompose. This is because the plastic will still exist even though it has broken down into smaller molecules. However, the degradation rate for pure PS was constant at the residual weight percentage of 97.24%.

Table 2. Decomposition rate of PS/PVL polyblend 50% and 95%

No	Polyblend	R^2	Regression equation	$t_{50\%}$ (day)	$t_{95\%}$ (day)
1	PS/PVL	1	-0.0495x+99.998	1010	1919

The water swelling test

The swelling test was carried out to obtain the percentage of swelling of the PS/PVL polyblend plastic film in water media and was carried out according to the ASTM D 570 method; ISO-62. Furthermore, the swelling test results will describe plastic resistance to water. The greater the absorption of water, the plastic resistance will be worse. As a result, microbes will be easier to biodegrade. Otherwise, the smaller the water absorption, the more difficult it will be for microbes to biodegrade because the polyblend has good water resistance [16].

Generally, plastic which has poor water resistance is hydrophilic. Intramolecular hydrogen bonds will be easier to occur between hydrophilic plastic and water. As a result, there will be an attraction between the plastic that has an OH group and H_2O. The outcome is that plastic will swell more easily.

In this study, PS/PVL polyblend was used with a ratio of 10/2. According to the data shown in Table 3, PS/PVL has good water resistance. No plastic water absorption (0%). Although PS/PVL has an OH group on the PVL side, PVL interacts only slightly with water. It is possible that the OH group in PVL has been tightly bound to the PVL carbon chain, making it difficult to interact with water molecules. As a consequence, it will be difficult for microbes to degrade PS/PVL [17].

On the other hand, Table 3 also shows that pure PS has good water resistance. Besides in the temperatures of 105 ºC, we also performed the swelling test at room temperature for 24 hours. The result, both PS/PVL and PS are fixed has good water resistance and does not absorb water at all (0%).

Table 3. The water swelling test at 105 ºC

No	Polyblend	Initial weight (gr)	Weight after soaked (gr)	Time (h)	Absorption (%)
1	PS/PVL	0.088	0.088	3	0
2	PS/PVL	0.088	0.088	6	0
3	PS	0.038	0.038	3	0
4	PS	0.038	0.038	6	0

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Conclusion

Landfill soil media can be used to degrade polyblend plastic PS/PVL and pure PS. The rate of biodegradation of the two plastic specimens was almost the same where the biodegradable PS/PVL polyblend was 2.97% while pure PS was 2.76%. However, the polyblend decreased significantly every 10 days while the pure PS was almost constant. Furthermore, based on the water swelling test, it was found that the PS/PVL polyblend and PS had good water resistance. As a consequence, it will be difficult for microbes to degrade plastic specimens. However, the presence of OH and carbonyl groups on the PVL side will make it easier for microbes to degrade PS/PVL compared to pure PS. Likewise, the biodegradation process will take a long time because of the weak intramolecular forces between polyblend and water. It is estimated, the time needed to degrade polyblend to the remaining 5% is for 1,919 days.

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Antioxidant activity of secondary metabolites of toba frankincense leaves (STYRAX *Paralleoncomud PERK*) by DPPH radical as scavenging

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Abstract. *Extraction of secondary metabolites of frankincense leaves (STYRAX paralleoncomud PERK) has been carried out with ethanol, ethylacetate and n-hexane as solvents by maceration . Based on phytochemical screening, large amounts of saphonins and tannins, moderate amounts of flavonoids and terpenoids (essential oils) and alkaloids were not detected in the three extracts. Secondary metabolites containing conjugated double bonds and phenolic ring will act as antioxidants, namely flavonoids and tannins, while steroids and saponins are not antioxidants because they do not contain conjugated double bonds and phenolic ring . Furthermore, antioxidant tests were carried out on ethanol and ethylacetate extracts containing antioxidant components. Determine of antioxidant properties was carried out chemically using DPPH (2,2-diphenyl-picrylhydarzil) as a radical scavenger. The power of inhibition was measured by visible light spectroscopy at a maximum wavelength (χ_{max}) of 517 nm with an damping time of 30 minutes with Vitamin C (Ascorbic Acid) as a control. The results obtained were IC_{50} of ethanol extract = 108,068 µg/mL, IC_{50} of ethylacetate extract = 124,97 µg/mL and IC_{50} of Vitamin C (Ascorbic Acid = 21,242 µg/mL). Based on these results, the antioxidant properties of the ethanol and ethylacetate extract are in the medium category,while ascorbic acid (vitamin C) as an antioxidant that is commonly consumed is very strong. Thus, the secondary metabolite extracts of the two enough potential to be used as antioxidants*.

Keywords: secondary metabolites, maceration, antioxidants and DPPH

Introduction

The frankincense plant is native to Indonesia which in the Tapanuli area is known as Toba frankincense (Styrax *paralleoncomud PERK*). This plant is spread in North Tapanuli Regency and all districts of North Tapanuli expansion, namely Humbang Hasundutan, Toba and Samosir Regencies [1,2,3]. The part of the frankincense plant that is widely used in the pharmaceutical and medicinal fields is the secondary metabolite of the resin, whereas the secondary metabolites are spread throughout the plant tissues, including the leaves. In this study, its utilization as an antioxidant was studied. Suggested that secondary metabolites in frankincense leaves were flavonoids, saponins, steroids and tannins in relatively high amounts, while alkaloids and terpenoids (essential oils) were not detected [4]. Furthermore, the Brine Shrimp Lethality Test (BSLT) toxicity test with Arthemia salia Lech as a bioindicator. The results showed that the LC_{50} (Letal Concentration 50) of the n-hexane extract was 1350 µg/mL, for the ethyl acetate extract was 18.98 µg/mL and the ethanol extract was 41.21 µg/mL. Based on the LC_{50} value obtained, the secondary metabolites in the ethyl acetate extract were very toxic, the ethanol extract was toxic, while the n-hexane extract was not. Thus, ethyl acetate and ethanol extracts are potential drug candidates [4,5,6,7,8]. In this study, its potential as a natural antioxidant has been studied chemically by using DPPH (2,2-diphenyl-picrylhydarzil) as a free radical scavenger using a visible spectrophotometer technique and Ascorbic Acid (Vitamin C) as a control [9,10]

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Methodology

Laboratory equipment and chemicals

The tools used are various glassware, analytical balance Metler Toledo Al-204, Buchner Merck Millipore filter, Visible Spectrophotometer and rotary evavorator 10-200L Standard. The material used was a sample of fresh Toba frankincense leaves (Styrax paralleoncomud PERK) from Samosir Regency and the chemicals used were pa Merck namely ethanol, n-hexane, ethyl acetate, FeCl 3.5%, 2N HCl, Dragendorff reagent, anhydrous acetic acid, H2SO 4 concentrated, anhydrous Na2SO4, filter paper, DPPH (2,2-diphenyl-1-picrylhydrazyl) (Sigma-Aldrich), distilled water and NaCl.

Isolation of secondary metabolites and phytochemical screening of Toba frankincense leaves (STYRAX paralleoncomud PERK)

Isolation was carried out by maceration with solvents of ethanol, ethyl acetate and n-hexane concentrated with an evaporator; Furthermore, the isolation test was carried out by maceration with solvents of ethanol, ethyl acetate and n-hexane and concentrated with an evaporator. Furthermore, the Alkaloid Group test was carried out by mixing 0.5 grams of sample with 1 mL of 2N HCl and adding 9 mL of distilled water, then adding 5 drops of Dragendorff's reagent, the presence of a brick red precipitate indicated the presence of the alkaloid group. The Flavonoid Group Compound Test was carried out by adding two drops of 5% FeCl3 solution to five drops of the sample on a drip plate. The occurrence of a color change to greenish or black-blue indicates the presence of flavonoids. The Saponin Group Compound Test was carried out by adding 1 mL of sample with 10 mL of distilled water, shaken for 10 minutes and leaving the foam and then left for about 10 minutes if the foam did not disappear, add 2N HCL if it disappeared, indicating the presence of saponin compounds. The test for steroid and terpenoid group compounds was carried out by adding 0.5 grams of extract with 10 drops of anhydrous acetic acid plus 2 drops of concentrated sulfuric acid, shaken and left for a few minutes. The appearance of red and purple colors indicates the presence of terpenoids, and the appearance of green and blue colors indicates the presence of steroids. The Tannin Group Compound Test was carried out by adding 0.5 grams of extract with 10 mL of distilled water and added with 3 drops of 1% $FeCl_3$. [11]

Antioxidant test of ethanol and ethyl acetate extracts with free radicals DPPH

A series of samples of ethanol extract and frankincense leaf ethyl acetate extract were prepared with concentrations of 100, 150, 200, 250 and 300 µg/mL (ppm). Each 2,5 mL sample was put into a test tube and 2,5 mL of 4 µg/mL DPPH solution was added . With the addition of the sample with the same volume of DPPH (2.5 mL) then the dilution factor becomes 2 times so that the measured concentration is divided into two, namely: 50,75,100,125 and 150. It's was left for 30 minutes and then the absorbance was measured with an Visible Spectrophotometer at a wavelength of 517 nm. Next, the absorbance of the blank solvents of ethanol and ethyl acetate was measured and the control DPPD DPPH 4 µg/mL. As a control, the absorption of ascorbic acid (Vitamin C) 2, 4, 6, 8 and 10 µg/mL was measured. Antioxidant activity is determined by equation.[12,13]

$$\text{Antioxidant activity} = [(\text{Controle} - \text{Asampel}) / \text{AControle}] \times 100\%$$

The value of IC_{50} (Inhibition Concentration) is determined based on the linear equation obtained through the Exel program.

Result and Discussion

Secondary metabolite isolation and phytochemical screening.

Fresh leaf samples of the Toba Frankincense plant (STYRAX paranelonerum PERK) were obtained from Samosir Regency, North Sumatra. The leaves are sorted and separated from other plant parts and then washed with running water and drained. Furthermore, the drying process is carried out at room temperature to avoid sunlight to prevent decomposition and oxidation of secondary metabolites contained in it. The dried leaves were then mashed with a blender and then filtered using a 60 Mesh sieve. Then maceration was carried out with ethanol, ethyl acetate extract and n-hexane. Extract concentration was carried out using rotary evaporation, until a thick extract was obtained. The results of the phytochemical screening aimed to identify the secondary metabolites in the three extracts of frankincense leaves with the results as shown in Table 1.

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Table 1: Results of phytochemical screening of toba frankincense leaf extract (STYRAX paralleoncomud perk).

Compound Group	Screening Results		
	Ethanol	**Ethyl Acetate**	**n-Hexane**
Alkaloid	-	-	-
Flavonoid	+	++	+
Saponin	+++	+	+++
Tanin	+++	+	+++
Steroid	-	++	-
Terpenoid	++	-	++

Description: (-) No reaction
(+) Reaction in small amount
(++) Moderate reaction
(+++) Reaction in bulk

Based on table 1, the secondary metabolites in frankincense leaves are saponins and tannins in large quantities, flavonoids and terpenoids (essential oils) in moderate amounts and alkaloids are not detected in the three extracts. The bioactive secondary metabolites as antioxidant are tannins (because of the conjugated double bonds) and flavonoids (because phenolic ring and some flavonoids contain conjugated double bonds in the C3 skeleton), so that the antioxidants determined are ethanol and ethylacetate extracts, in addition to the toxicity of ethyl acetate and ethanol extracts which strong and medium category. [13]

Secondary metabolite antioxidant test with free radical DPPH

The antioxidant activity of Toba Frankincense (Styrax *paralleoncomud Perk*) leaf extract was determined using DPPH (1,1-Diphenyl-2-Picrylhydrazyl) as a free radical scavenger. The DPPH method is relatively simple, easy, fast, high sensitivity and requires low samples. Absorption of residual DPPH was measured using an Visible Spectrophotometer at a wavelength of 517 nm and a soaking time of 30 minutes. Antioxidant test series concentration of ethanol and ethyl acetate extracts with concentrations of 50, 75, 100, 125 and 150 µg/mL and the concentration of DPPH is 4 µg/mL in ethanol and ethyl acetate pa. As a comparison is a solution of vitamin C with concentrations of 2, 4, 6, 8 and 10 µg/mL in ethanol, the absorbance measurement data is table 2 and the graph in Figure 1.

Table 2a: The results of the antioxidant activity of toba frankincense leaf ethanol extract (STYRAX paranelonerum PERK) with DPPH as a free radical

Concentration (µg/mL)	A Repetition			Average	A DPPH Inhibited	% Inhibition	IC_{50} (µg/mL)
	1	2	3				
50	0.278	0.280	0.281	0.280	0,031	9,967	108,068
75	0.19	0.208	0.216	0.205	0,106	34,083	
100	0.122	0.143	0.145	0.137	0,174	55,948	
125	0.117	0.118	0.119	0.118	0.193	63,057	
150	0.108	0.109	0.112	0.110	0,201	64,631	

Note: A Blank = 0.012, A Control = 0.311

Table 2b: The results of ethyl acetate antioxidant activity of toba frankincense leaf extract (STYRAX paranelonerum PERK) with DPPH as a free radical

Concentration (µg/mL)	A Repetition			Avarage	A DPPH Inhibuted	% Inhibisi	IC50 (µg/mL)
	1	2	3				
50	0,278	0,279	0,279	0,279	0,032	10,289	124,974
75	0.190	0.191	0.192	0.191	0,120	38,585	
100	0.183	0.184	0.187	0.185	0,126	40,405	
125	0.147	0.149	0.156	0.151	0,160	51,466	
150	0.132	0.135	0.137	0.135	0.176	56,591	

Note: Blank = 0.006, A Control = 0.622

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Tabel 2c: The results of the ascorbic acid (Vitamin C) antioxidant activity test of toba frankincense leaves (STYRAX paranelonerum PERK) with DPPH as a free radical

Konsentrasi (µg/mL)	A Pengulangan			Rerata	A DPPH Inhibuted	% Inhibition	IC50 (µg/mL)
	1	2	3				
2	0.292	0.293	0.298	0.294	0,017	5,466	21,242
4	0.281	0.282	0.283	0.282	0,029	9,324	
6	0.263	0.265	0.268	0.265	0,046	14,791	
8	0.248	0.25	0.261	0.253	0,058	18,649	
10	0.232	0.237	0.239	0.236	0,075	24,115	

Blank : 0.006 Control : 0.311

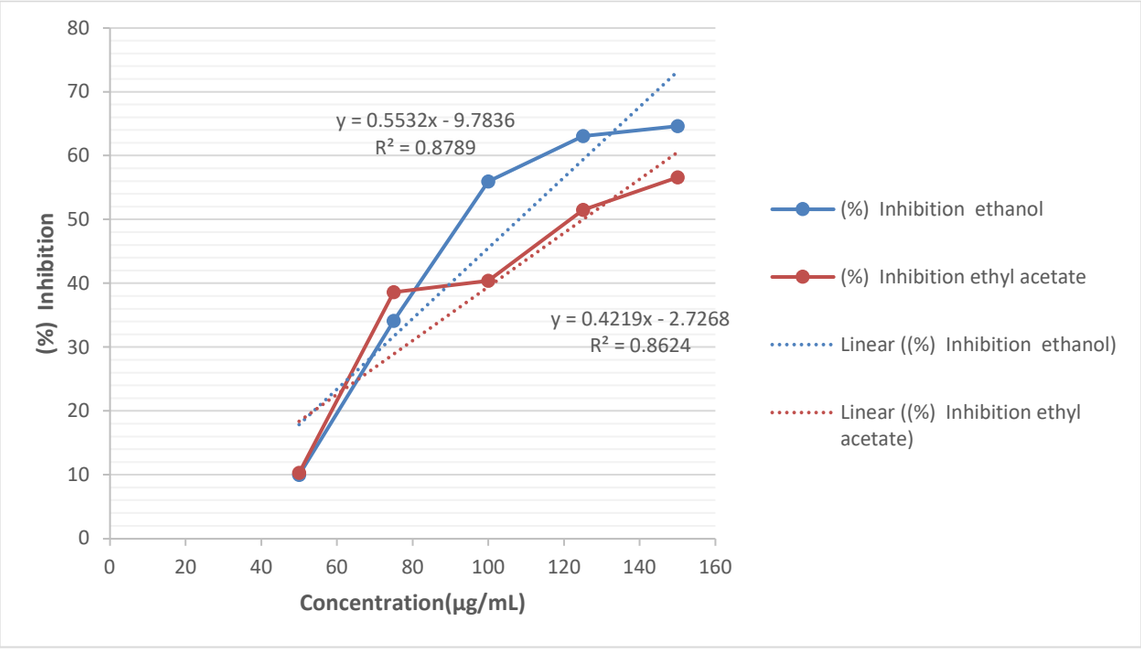


Figure 1a: Graph of inhibition (%) versus concentration (µg/mL) of ethanolic extract and acetic acid of toba frankincense leaf (STYRAX paranelonerum PERK)

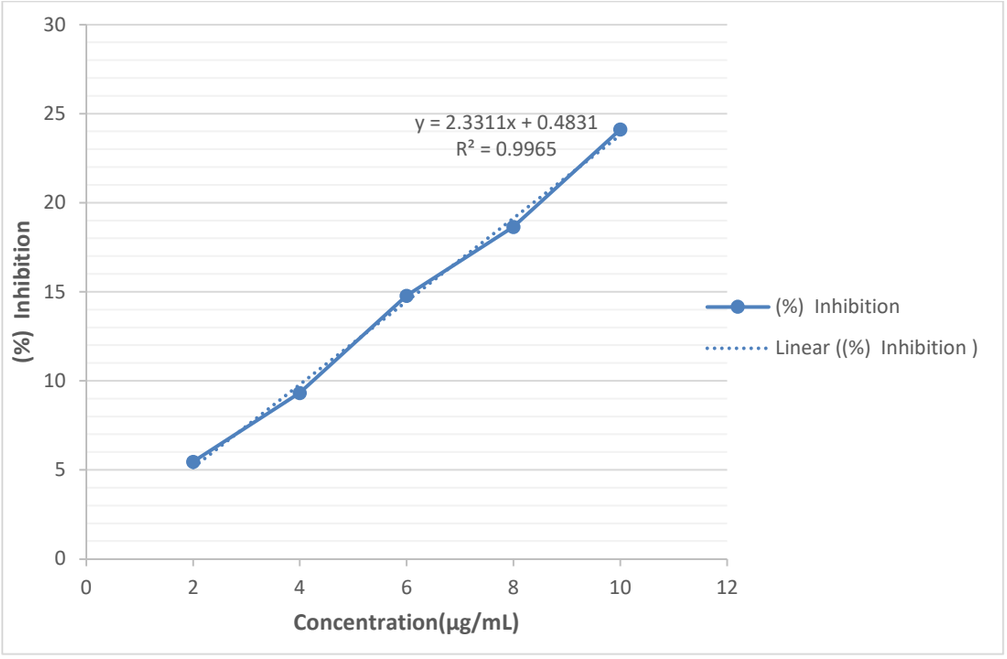


Figure 1b: Graph of inhibition (%) versus concentration (µg/mL) ascorbic acid (vitamin C)

The amount of antioxidant concentration that inhibits 50% of free radicals or IC_{50} is calculated by a linear equation obtained from the excel graph. The results obtained that the IC_{50} µg/mL of the ethanol extract was 108,068 µg/mL (moderate category), the IC_{50} of the ethyl acetate extract was 124,974µg/mL (moderate category) and the IC_{50} of ascorbic acid as a controlwas 21,242 µg/mL. Thus, both ethanol and ethyl acetate extracts have the enough potential to be used as antioxidants. Antioxidant properties are due to the Phenolic ring and conjugated double bonds,

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so the low category of antioxidant activity is probably because there is no conjugated double bond..[14,15,16,17].

Conclusion

Secondary metabolites in frankincense leaves are saphonins and tannins in large amounts, flavonoids and terpenoids (essential oils) in moderate amounts and alkaloids are not detected in the three extracts. The IC_{50} of ethanol extract was 108,068 µg/mL (moderate category), IC_{50} of ethyl acetate extract was 124,974 µg/mL (moderate category) and IC_{50} of ascorbic acid for comparison was 21,242 µg/mL (very strong category). Thus the two extracts (ethanol and ethyl acetate) are enough potential to be used as antioxidants.

Acknowledgement

Thank you to Unimed for funding this research through PNBP LPPM Unimed funds with the Basic Research Scheme for the 2022 Fiscal Year with Contract Number: 103/UN33.8/KEP/PPKM/PD/2022. Thanks are also conveyed to Cory Sisilia Silaban, a student of the Unimed Chemistry Study Program who was involved in this research in order to complete her Thesis.

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Proceeding of The 9th Annual International Seminar on Trends in Science and Science Education (AISTSSE), FMIPA Universitas Negeri Medan, Indonesia, November 8Th, 2022

Enhancements in crosslinks level, stiffness, strength, and elasticity of natural rubber/silica composite via using an aptes-silane agent

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Abstract. *Many rubber composite behaviours relate to the magnification of compatibility between reinforcing fillers with the basic rubbers. Much difference from carbon black, precipitated silica (silica) is more polar and less suitable to natural rubber (NR). As a method of enhancing the silica-NR compatibility, this study applies a typical silane agent, aminopropyltriethoxy silane (aptes silane). Therefore, this study observed the effects of aptes silane on the crosslinks level, stiffness, tensile strength, and elasticity of NR/silica composite. Silica as a reinforcing filler (30 phr) was loaded to the NR compound and, the aptes silane was added to the silica-loaded NR with varying amounts i.e., 1, 3, 5 and 7 phr. A specific semi efficient curing method was chosen to cure the NR/silica/aptes silane compounds, and the curing process was at 150 °C. It was revealed that the aptes silane enhanced the crosslinks levels, tensile strength, stiffness and elongation at break (elasticity) of the NR/silica composite. The greater the aptes silane amount, the greater level of crosslinks produced and, the stiffness, tensile strength and resilience behaviours were also enhanced because of crosslinks enhancement. From the results, the 5 phr of aptes silane was chosen as an optimum amount for the NR/silica compound.*

Keywords: natural rubber, aptes-silane, silica, crosslinks

Introduction

Generally, rubbers vulcanizates have good mechanical properties. But through filler reinforcement, the tensile strength, breaking elongations, and tensile moduli of gum/unfilled rubbers vulcanizates can be further enhanced by adding a certain dose of a typical reinforcing filler [1]. In the rubber industry, the main purpose of reinforcing filler additions is to lift the physical/mechanical properties of vulcanizates of rubbers. The enhancement in those properties depends on some factors, including the dose and compatibility of the reinforcing filler with the raw rubbers [2-5].

For many decades, precipitated silica has been used as one of the reinforcing fillers in the rubber industry. The reinforcing filler is a polar one as the result of its surface being full and saturated with the silanol groups and hence, relatively less compatible with natural rubber (NR) as one hydrophobic or non-polar rubber [6-8]. Academic researchers have been working to handle this weakness of silica by dozens of methods to lift the silica - NR compatibility including applying silane coupling materials [9] or compatibilizers [10-13], processing or dispersant aid [14, 15].

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One more research observation on the influence of aminopropyltriethoxy silane (aptes-silane) on crosslinks level, stiffness, tensile strength, and elasticity of the NR/silica composites was studied. The aptes-silane is a kind of technical silane coupling material with a molecule structure as, $C_9H_{23}NO_3Si$. The aptes-silane was added into NR/silica composites at 1, 3, 5 and 7 phr.

Methodology

The composite substances

NR was utilized as the raw rubber. Chemical substances like aminopropyltriethoxy silane (aptes-silane), $C_9H_{23}NO_3Si$, as the compatibilizer, N-isopropyl-N'-phenyl-p-phenylenediamine as an antioxidant, Vulcasil S (precipitated silica) as an applied reinforcing agent, sulphur as the cross-linker, mercapto-benzothiazolyl disulfide as an accelerator, zinc oxide as an activator and stearic acid as a co-activator were added into the composites as supplied.

The composite preparation

Table 1 exposes the formulation of a semi-efficient vulcanization type in making the NR/silica/aptes-silica composite. The making of the composites was on a 2-roll mill (ASTM D 3184/80).

Table 1. Natural rubber/silica/ aptes-silane composites

Composite ingredients	Parts per hundred NR (phr)
NR	100
Zinc oxide	5
Sulphur	1.6
Mercaptobenzothiazolyl disulfide	1.6
Vulcasil-S	30
N-isopropyl, N'-phenyl-p-phenylenediamine	2.2
Stearic acid	2.2
Aptes-silane	1 to 7

Crosslinks behaviour

The crosslinks behaviour of the NR/silica/aptes-silane composites was ruled by the swelling approach. The composite specimens were immersed in a chemical solution of toluene at ambient temperature for 7 days. The weights of the composite specimens before and after immersion were determined. The swelling percentage of the specimens at equilibrium (Q) was calculated by Equation (1).

$$Q\ (\%) = (W_2 - W_1) / W_1 \quad (1)$$

Where W_2 and W_1 are the swollen and initial weights of the observed composite specimens, respectively.

Strength property

The strength as tensile strength (TS), tensile moduli at elongation 100% (M100) and, elongation at break (EB) of the dumbbell-shaped test specimens of NR/silica/aptes-silane composites were ruled using a typical tensile machine Instron-3366 at a crosshead speed of 500 ($mmxmin^{-1}$) in accordance to ISO 37.

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Results and discussion

The crosslinks level

The swelling behaviour/percentage of the NR/silica/ aptes-silane composite with the variation of aptes-silane doses is visualized in Fig. 1.

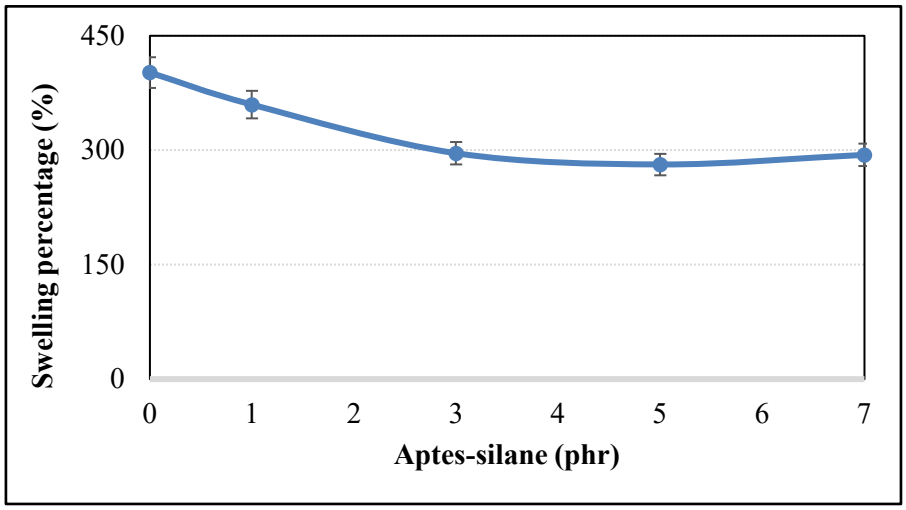


Figure 1. Swelling percentage vs aptes-silane doses

As visualized in Fig. 1, the swelling percentage of NR composite with 1 phr of aptes-silane was smaller than that of NR composite with no aptes-silane filled. The additions of aptes-silane doses up to a 5 phr further decreased the swelling percentage and started to increase beyond the 5 phr of aptes-silane dose. The swelling percentage interprets the crosslinks level of the NR composites [16]. A greater swelling percentage means a lower crosslinks level and, total crosslinks are the total of crosslinks that were formed chemically and physically. The additions of aptes-silane until a 5 phr increased the crosslinks level. It was as a result of the performance of aptes-silane that not only transformed the hydrophilic silica into a more hydrophobic silica which was more compatible with NR and hence, the aptes-silane presence might be reduced the action of filler to filler and lifted the action of rubber to filler; causing in the producing of NR-aptes silane-silica coupling bonding that might be counted as a new type of crosslinks.

The reduction in crosslinks level afterwards a 5 phr of aptes-silane dose was a result of the dilution influence of the more quantity of aptes-silane that lowered the crosslinks level.

The stiffness and strength

Figs. 2-4 visualize the tensile behaviours e.g., M100, TS and EB of the NR/silica with no/with aptes-silane at various doses. As visualized in Figs. 2 and 3, the TS (indicates the strength) and M100 (indicates the stiffness) of the NR with the doses of aptes-silane till 5 phr were greater than those of NR/silica with no aptes-silane. Those strength and stiffness behaviours have similar trends. Those properties started to decrease with a further increase in the aptes-silane dose at 7 phr.

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Since the properties of TS, M100, and stiffness of a rubber product are equal to the level of crosslinks; the strength and stiffness were enhanced with the additions of aptes-silane till 5 phr. It was due to a bigger crosslinks level as a result of creating NR-aptes silane-silica coupling bonding that increased the level crosslinks of the NR/silica composites. Therefore, aptes-silane made the crosslinks level enhancement.

The deterioration in strength and stiffness afterwards a 5 phr dose of the aptes-silane as result of the excessive amount of aptes-silane that lowered crosslinks level. It might be assumed that more aptes-silane presence created an accumulation of aptes-silane that bounded the curatives and hence, diminished the crosslinks level.

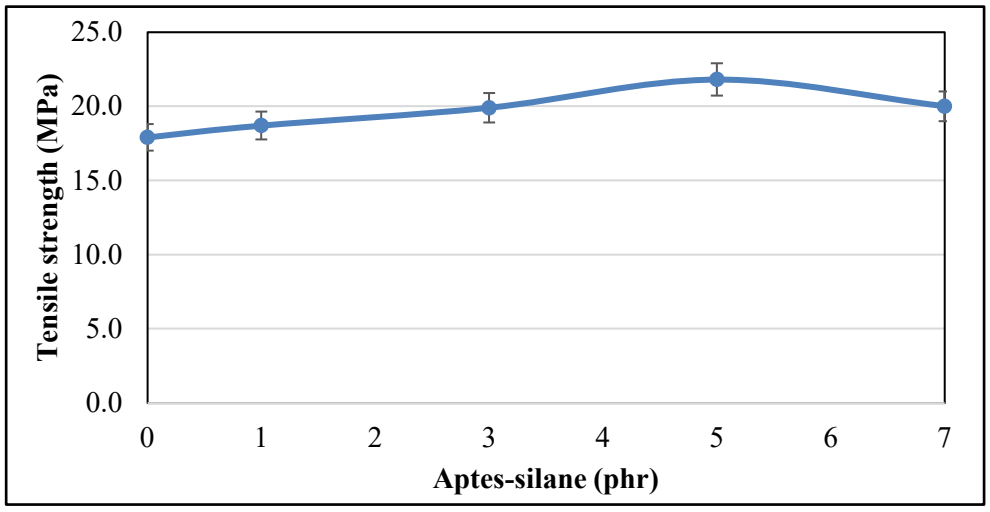


Figure 2. The tensile strength vs aptes-silane doses

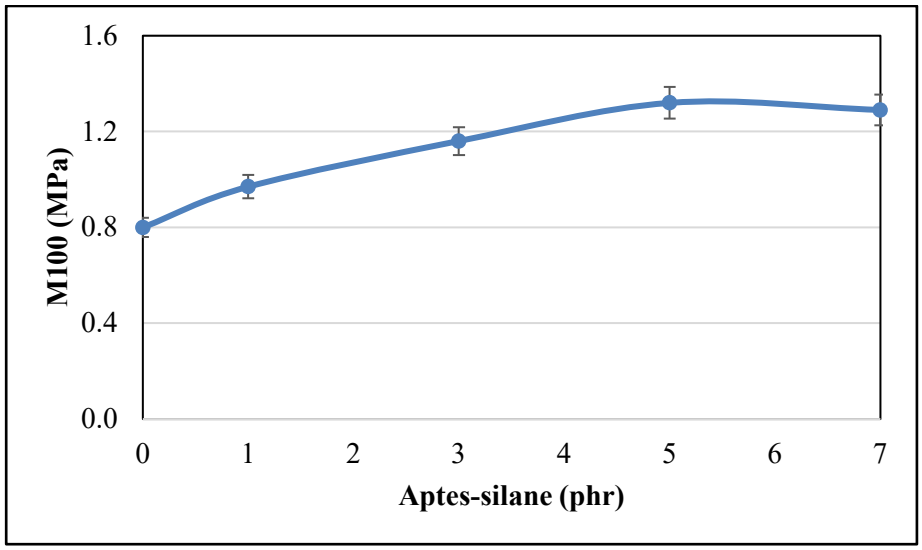


Figure 3. The M100 vs aptes-silane doses

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The elasticity

The elasticity of a rubbery material is the ability of the elastomer to resume its normal shape beyond being compressed or stretched. The elasticity can be indicated by the elongation at break property of a rubber vulcanizate. Figure 4 visualizes the effect of aptes-silane addition on the breaking elongation of NR/silica. As seen, the EB of NR composites with the doses of aptes-silane till 3 phr were bigger than that of NR composite filled with no aptes-silane and then, the EB was decreased with further increase of aptes-silane doses after 5 and 7 phr. Since the EB behaviour calculates mainly on crosslinks level. The decrease in EB till a 5 phr was a result of greater total crosslinks that retarded the NR chain's mobility from the surface of silica. The increase in EB afterwards a 5 phr was a result of crosslinks deterioration.

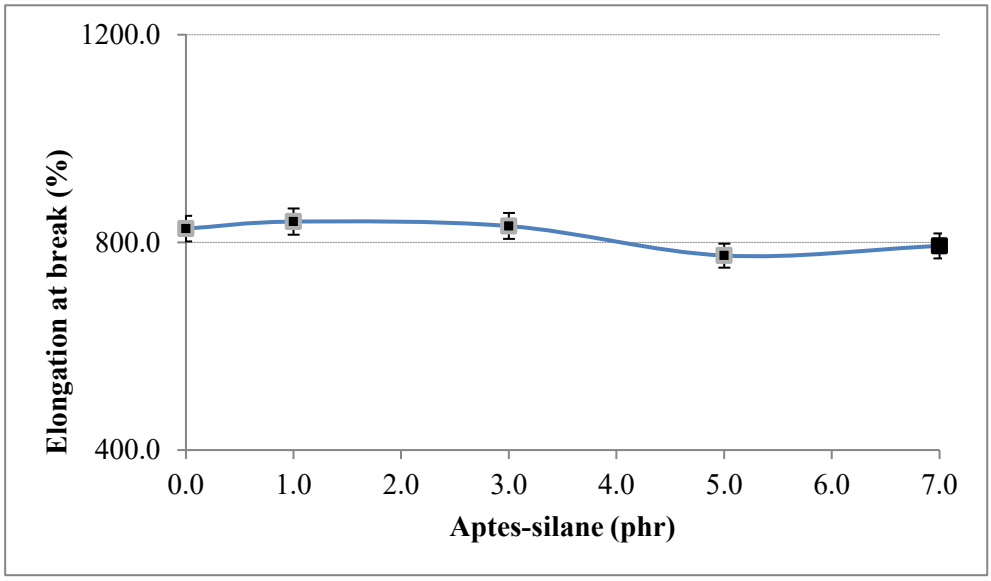


Figure 4. The elongation at break (elasticity) vs aptes-silane doses

The resilience

Figure 5 visualizes the influence of aptes-silane on the property of resilience of the NR/silica. The resilience also indicates the elasticity of a rubber vulcanizate. The figure shows that the aptes-silane shifted the resilience property until a 5 phr of aptes-silane and, started to reduce the resilience property as the aptes-silane amount further increased. Resilience like tensile moduli and stiffness properties depends on the level of crosslinks level [17, 18]. The resilience shifting until a 5 aptes-silane addition was because of a greater crosslinks level and, the resilience reduction afterwards a 5 phr of aptes-silane addition was because of a lower crosslinks level.

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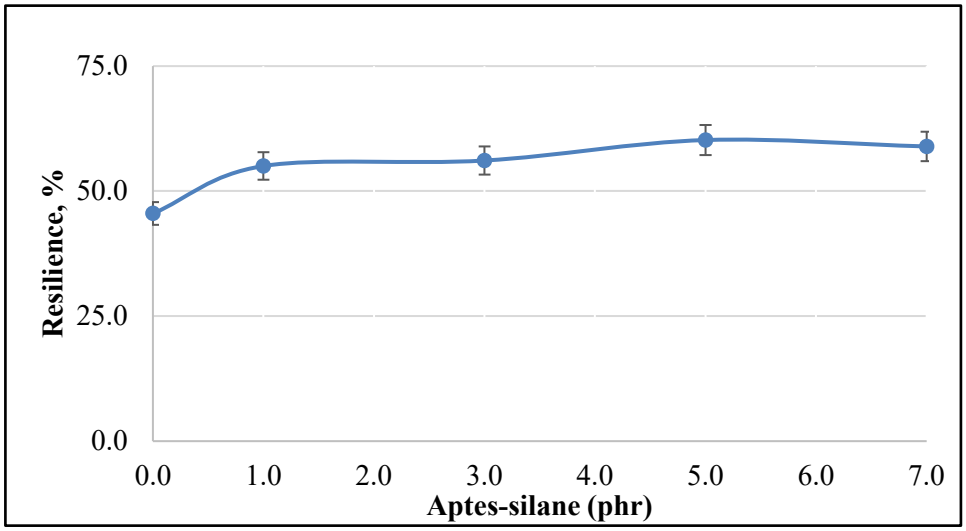


Figure 5. The resilience vs aptes-silane doses

Conclusion

The crosslinks level, stiffness, tensile strength, and elasticity of the natural rubber/silica composite were shifted by the incorporation of aptes-silane (aminopropyltriethoxy silane). The aptes-silane successfully promoted the crosslinks level enhancement through the compatibilization of natural rubber–silica interaction. This research results contributed to an understanding of the role of aptes-silane as an alternative compatibilizer ingredient for the compound of natural rubber and silica and as a source of valuable information for producing such rubber compound/composite.

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Proceeding of The 9th Annual International Seminar on Trends in Science and Science Education (AISTSSE), FMIPA Universitas Negeri Medan, Indonesia, November 8Th, 2022

The compounds of natural rubber-silica-aptes silane: an observation on curing, filler dispersion, crosslinking and morphological behaviors

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Abstract. *Semi efficient method was chosen as the recipe for making the compound of natural rubber (NR)/silica/aptes silane and curing process on the compound. The NR/silica/aptes silane compound was cured at 150 °C and, the influences of a typical aminopropyltriethoxy silane (aptes silane) on curing, filler dispersion, crosslinking and morphological behaviors of the NR/silica compound were examined. As a natural-based rubber; the NR was loaded by silica as a reinforcing filler at a fixed amount i.e. 30 phr. As a filler dispersant for rubber compounds, the aptes silane was incorporated into the NR/silica mixture with varying amounts (1, 3, 5 and 7 phr). It was found that the aptes silane was successfully applied in shifting the level of silica dispersion in the NR/silica compound. The aptes silica also shifted the curing state, as well as crosslinking level. The bigger the aptes silane amount; the greater the curing rate index but the smaller the minimum torque value. The aptes silane shifted the delta torque and crosslinking level up to a 5 phr and, further increase the aptes silane amount caused by decreasing those NR/silica behaviors. From the morphological observation, it was found that the aptes silane incorporations produced SEM images with bigger matrixes tearing and matrixes breaking lines. The 5 phr was chosen as the optimum amount of aptes silane for the NR/silica compound.*

Keywords: compound, natural rubber, silica, silane, curing

Introduction

The curing process changes the base rubbers into rubbers vulcanizates with wanted mechanical properties [1]. A further enhancement in rubbers vulcanizates properties can be achieved by adding a certain dose of a type of reinforcing filler [2-4]. The main purpose of exploiting the reinforcing fillers is to enhance the physical or mechanical behaviors of vulcanized rubbers. The enhancement in those properties depends on some factors, including the type not only the quantity or dose of chosen reinforcing filler but also the compatibility between the base rubbers and the reinforcing fillers [5].

For many years, there are two types of popular reinforcing fillers. They are carbon black (CB) and precipitated silica (silica) [6-8]. The CB is a black filler and silica is a white filler. Silica has been used as one of the reinforcing fillers in the rubber industry in producing rubbers vulcanizates

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with light colours. It is a hydrophilic or polar filler, so many silanol groups on its particle surfaces and hence, it makes the reinforcing filler relatively not suited to natural rubber (NR) as one of hydrophobic or nonpolar rubber [9-11]. Recently, many research workers have been examining to study intensively on this silica deficiency by some trying to enhance the silica-NR compatibility. Tries include applying coupling agents [12] or compatibilizers [13, 14] or processing/dispersant aid [15, 16].

Another examination of the effects of aptes silane, as an abbreviation of aminopropyltriethoxy silane, on the morphology and tensile behaviors of the NR/silica composite was examined. The aptes silane is typical of commercialized silane coupling agents. Referring to Figure 1, the element of amine is shown inside the aptes silane material. As an additive, the aptes silane was added into the NR/silica system with varied amounts i.e., 1 to 7 phr. The influences of aptes silane on curing, filler dispersion/distribution, crosslinking, and morphological behaviors of NR/silica with and without no aptes silane were examined.

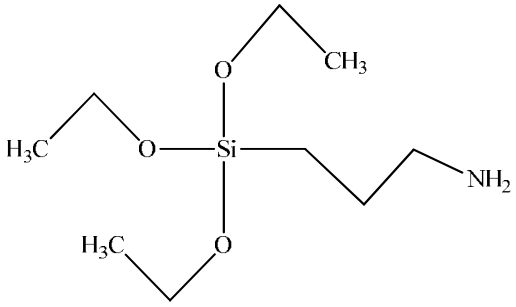


Figure 1. The molecule structure of aminopropyltriethoxy silane (aptes silane)

Methodology

The rubber and other rubber chemicals

NR was used as the base rubber. The aptes silane ($C_9H_{23}NO_3Si$) was used as the additive for the NR/silica composites, Isopropyl-N'-phenyl-p-phenylenediamine as an antioxidant, vulcasil-s (precipitated silica) as the material to reinforce the composite, sulphur as the material to crosslink the base rubber, mercaptobenzothiazolyl disulfide as the material to accelerate the curing process and zinc oxide/stearic acid as the activator and co-activator. The base rubber and the rubber materials were exploited as supplied.

Rubber composite preparation

Referring to one typical semi-efficient formulation, the NR/silica composite was prepared. The rubber composites were prepared on a 2-roll mill (ASTM D 3184/80). Table 1 tabulates the formulation of the NR with no/with aptes silane.

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Table 1. The NR and rubber material for NR/silica composite preparation

NR, rubber materials	Amount-phr.
NR	100
Zinc oxide	5
Aptes silane	1; 3; 5; 7
Sulphur	1.6
Mercapto-benzothiazolyl disulfide	1.6
Silica	30
Stearic acid	2.1
Isopropyl-N'-phenyl-p-phenylenediamine	2.1

Crosslinks level measurement

The crosslinks level of NR/silica/ aptes silane was measured by its torque behaviors i.e., delta torque, and maximum and minima torques of the NR composite. The delta torque is equal to maximum torque minus minima torque, and the value of delta torque indicates the crosslinks level. The less the delta torque, the lower the crosslinks level.

Hardness behavior

The hardness behaviour is in Shore A which was determined by ISO 7691-I using the Durometer (Shore Type A).

Elongation at break, tensile moduli and strength behaviors

The dumbbell-shaped NR/silica/aptes silane samples (ISO 37) were tested to examine tensile behaviors. Stresses at low (100%), elongation at break and strength at break. The tests were performed on an Instron (Instron3366) with speed at a 500 ($mm.min^{-1}$) crosshead speed and installed on a computer. The samples with a dimension width of 10 mm, length of 100 mm, and thickness of 2 mm were prepared from press-cured sheets by using a cutter. For each sample at least 5 specimens were tested.

Morphology behavior

The morphology behavior of the NR composites with a size of about (1 cm × 1 cm) was prepared beyond the tensile test. Every specimen was carefully put on double-sided scotch tape and then, a very thin gold layer was coated onto the specimen surface. The morphology behaviour of the fractured surface of the films was studied under a typical scanning electron microscope (SEM) to have the information relating to the filler distribution level and to examine the available formation of some micro-defects.

Results and discussion

Curing behaviors

Figure 2 visualizes the effect of aptes silane on the curing time of NR/silica. Compared to NR/silica with no aptes silane, NR/silica with aptes silane has a lower curing time. It was shown that the additive was a co-curing substance.

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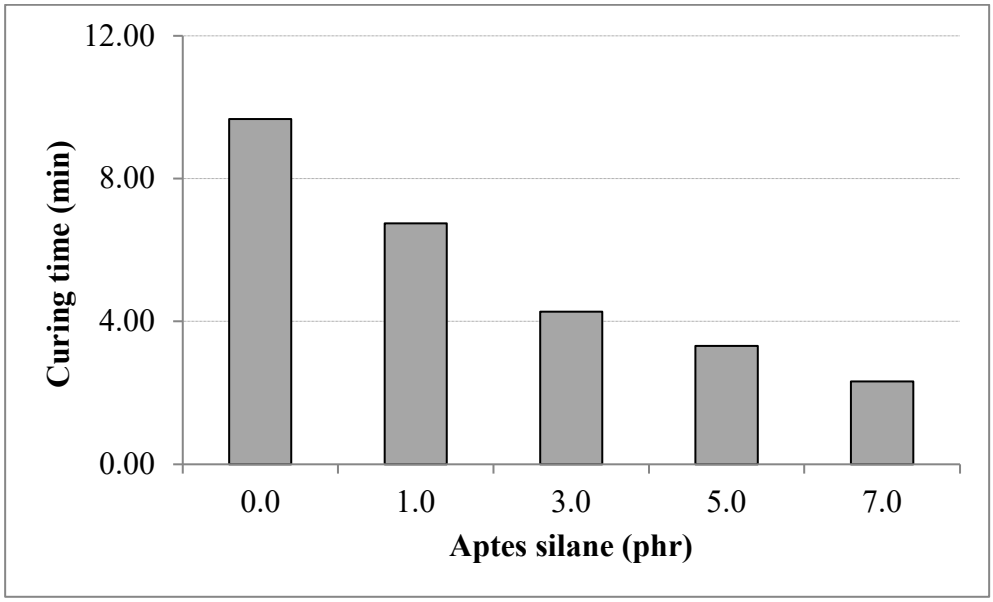


Figure 2. Curing time vs aptes silane amount

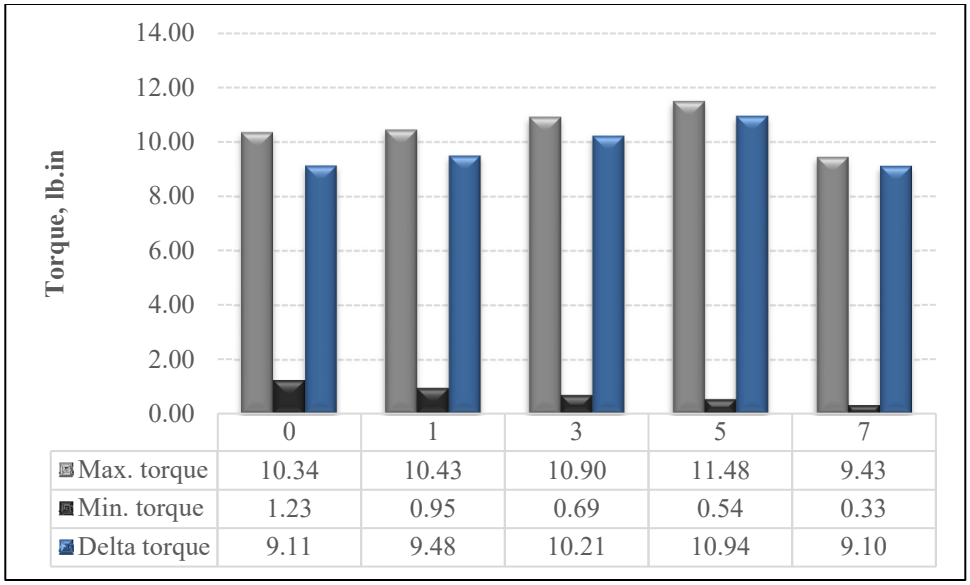
As can be seen, the bigger the aptes silane amount, the shorter the curing time. Positively, it was due to the presence of an amine substance. See Fig. 2, the aptes silane has amine in its molecule. An Amine is one of activators for accelerator which shortens the curing time [17, 18].

Delta torque/crosslinks behaviors

Since the delta torque is remembered to indicate the crosslinks level of a rubber/elastomer compound [19 - 21]. The less the delta torque value, the lower the crosslinks level. Therefore, the crosslinks behavior of the NR/silica/aptes silane composite was studied based on its delta torque behavior. Figure 2 demonstrates the torque behavior of NR/silica/aptes silane including delta, maximum and minimum torque. The delta torque is the difference between the maximum torque and minima torque.

From Fig. 2, the additions of aptes silane up to 5 phr into the NR/silica compound shifted the delta torque. It was clearly because of the function of the aptes silane that converted the hydrophobic silica into a hydrophilic one. This latter type of silica became more compatible with NR and hence, the incorporation of aptes silane not only weaken the filler-to-filler interaction but also shifted the rubber-to-filler interaction; causing the increasing the crosslinks level. The diminishing of the delta torque beyond the 5 phr of aptes silane was positive because of any dilution influence of the excessive amount of the additive which diminished the crosslinks.

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	0	1	3	5	7
Max. torque	10.34	10.43	10.90	11.48	9.43
Min. torque	1.23	0.95	0.69	0.54	0.33
Delta torque	9.11	9.48	10.21	10.94	9.10

Figure 3. The torques vs aptes silane amount

Filler distribution behaviors

The degrees of silica distribution of NR/silica with no aptes silane and NR/silica/aptes silane were determined by Equation (1) [22], as follows;

$$L = \eta r - mr \quad (1)$$

In which ηr = [MLf / MLg], and mr = [MHf / MHg]; whilst MLf and MHf were the minima and the maximum torques of the filled compounds; and MLg and MHg were the minima and the maximum torques of the unfilled/gum NR compound. Based on previous research result, MHg=4.88 and MLg=0.07 [23]. The bigger the L value at a fixed silica amount, the poor the silica distribution.

The L value is visualized in Figure 3. As seen, the L value of NR/silica with no aptes silane is the highest one. It was because the silica surface was fully saturated with silanol and, they produced relatively weak interaction with NR [24] and hence, the silica distribution was poor. The aptes silane 1 phr reduced the L value. It was because of the polar component of the additive which provided stronger silica and converted the silica filler into a more hydrophobic hence, the silica was more suitable with NR and improved the degree of filler distribution, respectively. The bigger the aptes silane amount; the less the L value, and the better silica distribution.

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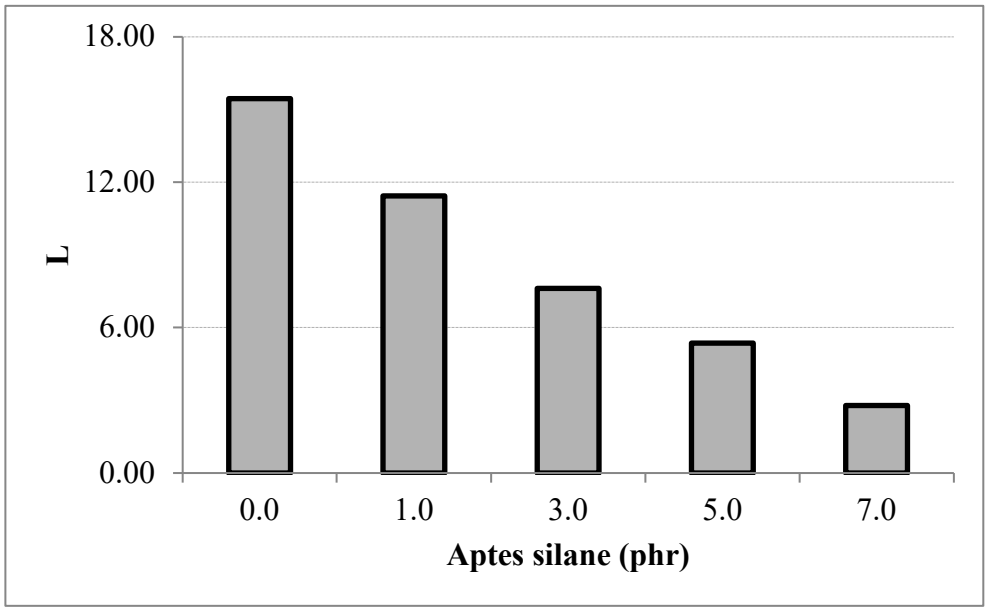


Figure 4. The L value vs aptes silane amount

The morphology behavior

The scanning electron microscopy (SEM) images are visualized in Figure 4 which show the fractured surfaces of NR/silica with/with no aptes silane at a 500x magnification. The images showed the homogeneity of the silica distribution because of the aptes silane incorporations. The silica distribution was the poorest homogeneous in (I) which showed larger silica flocs (see the signs in Fig. 4 (I). The image of (a) also looked relatively even compared to the others. It means that (I) was less malleable than the others. But, the image for (III) phosphoresces the largest matrix breaking line and surface roughness when compared to (II) and (IV). A better filler distribution in (III) changed the crack path that led to an enhanced crack-resistance process and hence, caused the moduli and TS improvements. The rupture energy enhancement was probably because of a better filler distribution of silica and it relates to the state of roughness and/or matrix tearing form of the broken specimen. An enhancement in rupture energy is the consequence of the roughness and matrix tearing line of the broken surface of rubbers composites samples [15]. But the matrix tearing rows and surface roughness of (I) and (IV) were smoother compared to (II) and (III) which produced less tensile strength.

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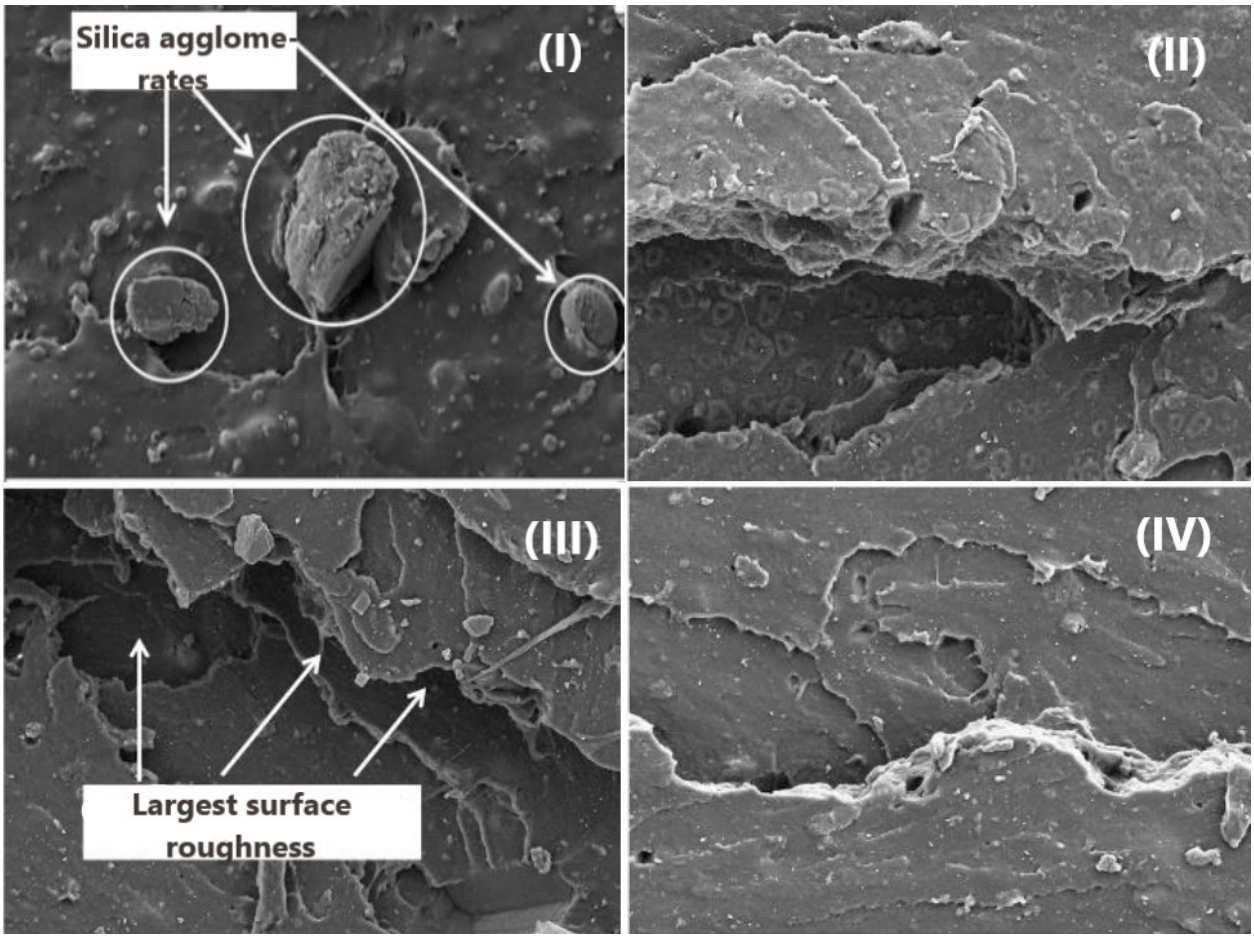


Figure 5. Scanning electron microscopy images of the failed fracture of NR/silica with/with no aptes silane, at a magnification of 500x: (I) No aptes silane, (II) aptes silane at 3 phr, (III) aptes silane at 5 phr, and (IV) aptes silane at 7 phr.

Conclusions

The curing time, filler degree distribution and crosslinking level of the natural rubber/silica were shifted by the aptes silane. Presumably, the aptes silane provided a better curing state and degree of filler distribution as well as crosslinking enhancement to the natural rubber/silica. The scanning microscopy electron (SEM) images have confirmed that the aptes silane shifted the degree of silica distribution. This finding provides knowledge of the usage of aptes silane as one natural rubber additive and, it is one source of valuable information in producing natural rubber composite.

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Nitrogen mineralization of two different reclaimed-mining soils treated with organic matter and coal-fly ash

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Abstract. *Nitrogen mineralization is the biochemical processes controlling the availability of nitrogen in soils; therefore, information on factors controlling nitrogen mineralization is a key for successfulness of revegetation in reclaimed-mining soils (RMS). This study aimed to examine the effect of organic matter and coal-fly ash on nitrogen mineralization in RMS with different characteristics. Empty fruit bunch of oil palm (EFBOP) individually or in combination with coal- fly ash (CFA) was added to two RMSs (Palam and Cempaka Soils) and quartz (control). The mix of soil/quartz–EFBOB/CFA was then incubated at 60% water-filled pore space in the dark for 30 days, and the concentrations of NH_4^+ and NO_3^- in soils were quantified the end of incubation period. The results showed that nitrogen mineralization of Palam Soil and Cempaka Soil showed different responses to the application of EFBOP and CFA. The application of EFBOP increased the concentration of NH_4^+ in both RMS, in which increasing NH_4^+ in Cempaka Soil reached 239% while the increasing NH_4^+ in Palam Soil only reached 169%. When EFBOP was combined with CFA, the increase in NH_4^+ in Cempaka Soil was 385% compared to 253% in Palam Soil. The results also showed that the NO_3^- contents in all treatments were*

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higher than the NH_4^+ content. The difference in nitrogen mineralization in the two soils is related to differences in soil characteristics between these two soils, in which Palam Soil has a lower pH and higher Al and Fe contents than Cempaka Soil. The results of this study indicate that the effect of the application of organic matter and coal-fly ash on nitrogen mineralization was controlled by soil characteristics.

Keywords : microbial decomposition, amonification, nitrification, stabilization, protien, amino acids

Introduction

Coal mining activities in Indonesia which is carried out using an open pit system causes the formation of reclaimed -mining soils. The main obstacle to reclaimed-mining soils for plant growth is the low content of nutrients and high soil acidity [1-3]. Observations showed that reclaimed-mining soils had organic C contents ranging from 5.6 g kg^{-1} to 15.9 g kg^{-1} [4], and contained high amounts of heavy metals [5, 6]. The results of this study indicate that soil quality improvement is essential for reclaimed-mining soils prior to the revegetation is carried out in these soils.

Nitrogen is the fourth largest nutrient required by plants for development and growth [7]. The main function of nitrogen is as a synthetic material for chlorophyll, protein and amino acids, so that nitrogen is required in large quantities, especially in the vegetative phase growth[8]. The main source of nitrogen is nitrogen gas in the atmosphere, and only a small amount originated from the soils [9]. In a study on the characteristics of reclaimed mining soils with different ages of revegetation, Iskandar et al. [10] reported that nitrogen stock increased from 0.5 g kg^{-1} in 0–2-year-since revegetation to 1.3 g kg^{-1} in the reclamation area of 10–12 years since revegetation. This increase in nitrogen contents originated from the litter and roots of pioneering plants and the legume cover crop and grass [10]. Although it has increased with increasing age of revegetated plants, the total nitrogen content in reclaimed-mining soils is generally still low, in the range of 0.80–1.49 g kg^{-1} [11]. Therefore, it is necessary to apply inorganic and organic fertilizers to increase the availability of nitrogen in reclaimed-mining soils.

Soil ameliorant application is an option to overcome the problem of low nitrogen availability in reclaimed-mining soils. Ameliorant materials frequently used to improve soil fertility of reclaimed-mining soils are empty fruit bunch of oil palm (EFBOP) and coal-fly ash (CFA). EFBOP is applied to soils with the aim of improving soil physical properties and as a source of nutrients [12, 13], while CFA is applied to soils for increasing soil pH [14, 15]. Although many studies have been conducted to determine the role of soil ameliorant in improving nutrient availability in reclaimed-mining soils [16, 17], there is a lack of information on the effect of reclaimed-mining soil characteristics on nitrogen mineralization. Reclaimed-mining soils with different characteristics may have different responses when receiving the same amount of organic matter. Information about the relationship between soil characteristics and the rate of nitrogen mineralization of reclaimed-mining soils is crucial in determining the success of improving the quality of reclaimed-mining soils by organic matter application [18, 19]. Therefore, this research aims to quantify nitrogen mineralization of two reclaimed-mining soils experiencing different soil characteristics treated with organic matter and coal-fly ash application.

Methodology

Sampling and Characterization of Soils, Coal-Fly Ash and Organic Matter

A diamond reclaimed-mining soil (Palam Soil) and a coal reclaimed-mining soil (Cempaka Soil), which are administratively situated in Cempaka Sub-district, Kota Banjarbaru, South Kalimantan,

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Indonesia were sampled at a depth of 0-30 cm using soil auger at different sampling point. After cleaning from plant debris and gravels, sampled soils were then homogenized, placed into plastic bags and stored at 4 ºC until further used for the research. Soil samples were then characterized for soil fraction using the pipette method [20], soil pH [21], organic C content [22], total nitrogen [23], phosphorous and potassium extracted using HCl 25% [24], and exchangeable cations (Ca, Mg, K and Na) ([25, 26]. Cation exchangeable capacity (CEC) of soils was determined using the method described by Rhoades [27]. Total contents of Al, Fe and Mn in soils were quantified using the digestion of $HClO_4$ and HNO_3 admixture and the atomic adsorption spectrophotometry (AAS) quantification.

Coal-fly ash was collected from a disposal site of a power plant situated at Desa Kasiyau Raya, Murung Pudak Sub-district, Tabalong Regency, South Kalimantan, Indonesia. Following sampled in the field, CFA was air-dried, passed through a 2.00 mm sieve, and stored until to be used for the experiment. Prior to the incubation experiment in the laboratory, CFA was digested using $HClO_4$ and HNO_3 admixture, subsequently the quantification of Ca, Mg, K, Na, Al, Fe and Mn was conducted using an atomic adsorption spectrophotometry (AAS) (Shimadzu AA6300G).

The organic matter used for this experiment was empty fruit bunch of oil palm (EFBOP), which was sampled from the palm oil mill of the Perkebunan Nusantara XIII at Desa Ambungan, Pelaihari Sub-district, Tanah Laut Regency, Indonesia. The samples were oven-dried at 60 ºC for 72 hours, fine-ground to a-2 mm size, and quantified for lignin- [28], carbohydrate- [29], organic C- [22], and total N- [23] contents.

Incubation Experiment

The effect of EFBOP and CFA applications on the nitrogen mineralization was quantified through an incubation experiment in the laboratory. The treatments tested include: (1) Cempaka Soil, (2) Cempaka Soil + EFBOP, (3) Cempaka Soil + EFBOP, (4) Palam Soil, (5) Palam Soil + EFBOP, (6) Palam Soil + EFBOP + CFA , (7) quartz, (8) quartz + EFBOP, and (9) quartz + EFBOP + CFA. Each treatment had three replications. A 500 g of each soil and quartz was placed in an incubation pot (diameter of 8.0 cm; height of 15.0 cm), and EFBOP and CFA were then added to the pot according to treatment. The amount of EFBOP and CFA added to the incubation pot was equivalent to the field application of 20 Mg ha^{-1} and 100 Mg ha^{-1}, respectively. Aquadest was added to each pot to obtain a water content of 60% of water-filled pore space, then each pot was incubated at room temperature for 30 days. The water content during the incubation period is maintained constant by adding aquadest to each pot for compensation of water loss due to evaporation.

The contents of NH_4^+ and NO_3^- in soils were determined after the completion of incubation period by sub-sampling of 100 g of soil for each pot. Contents of NH_4^+ and NO_3^- in soils were quantified using the method described by Bundy and Meisinger [30]. The effect of EFBOP and CFA on nitrogen mineralization was quantified using analysis of variance (ANOVA), which was then followed by a mean difference test using the least significance difference (LSD) at $P < 0.05$.

Results and discussion

Quartz sand has a neutral acidity level (pH 6.98), with very low organic C and total nitrogen contents. Exchangeable cations (Ca, Mg, K and Na) and total Al, Fe and Mn of quartz sand were also very low (Table 1). Very low exchangeable cations for quartz sand corresponded to the characteristics of quartz sand which has a very low cation exchangeable capacity (CEC) (Table 1).

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Palam Soil had a soil texture of clay, with a very acid soil level (soil pH of 3.12). The organic C content in Palam Soil reached to 12.56 g kg^{-1}, with a total N content of 6.08 g kg^{-1} (Table 1). The contents of exchangeable cations were in the range of 0.98–2.12 cmol kg^{-1}, with a CEC of 23.45 cmol kg^{-1}. The total content of Al and Fe in Palam Soil was also high, reached to 49 and 51 g kg^{-1}, respectively (Table 1). Contras to Palam Soil, Cempaka Soil had a soil texture of clay loam, with a slightly acidic level of acidity (soil pH of 5.12). The organic C content and total nitrogen in Cempaka Soil were 12.23 g kg^{-1} and 7.87 g kg^{-1}, respectively (Table 1). Exchangeable cation contents and CEC of Cempaka Soil were higher than those of Palam Soil (Table 1). However, Cempaka Soil has a lower total content of Al and Fe (7.76 mg kg^{-1} and 5.76 mg kg^{-1}) compared to Palam Soil (Table 1). These results indicate that the two reclaimed-mining soils used for this experiment have different soil characteristics.

Table 1. Properties of two reclaimed-mining soils and quartz sand used for the experiment. Numbers after "±" indicate the standard deviation of mean (n=3).

Properties	Quartz sand	Palam soil	Cempaka soil
Soil fraction			
Sand (%)	-	20.88 ± 4.74	23.92 ± 3.43
Silt (%)	-	32.56 ± 5.76	43.52 ± 2.21
Clay (%)	-	46.56 ± 2.53	32.56 ± 3.21
pH H_2O	6.98 ± 0.71	3.12 ± 0.98	5.12 ± 0.98
Organic C (g kg^{-1})	0.12 ± 0.08	12.56 ± 0.05	12.23 ± 0.54
Total N (g kg^{-1})	0.06 ± 0.01	6.08 ± 0.01	7.87 ±0.12
P HCl 25% (g P_2O_5 kg^{-1})	1.23 ± 0.12	14.34 ± 1.23	35.32 ± 2.34
K HCl 25% (g K_2O kg^{-1})	0.67 ± 0.08	12.45 ± 2.34	43.43 ± 3.45
P-Bray I (mg kg^{-1})	0.21 ± 0.03	4.32 ± 0.23	12.45 ± 1.23
Exchangeable Ca (cmol kg^{-1})	0.12 ± 0.02	2.12 ± 0.34	8.84 ± 1.21
Exchangeable Mg (cmol kg^{-1})	0.14 ± 0.04	1.23 ± 0.08	6.12 ± 1.54
Exchangeable K (cmol kg^{-1})	0.08 ± 0.01	0.98 ± 0.05	4.23 ± 0.98
Exchangeable Na (cmol kg^{-1})	0.09 ± 0.02	1.21 ± 0.23	2.45 ± 0.96
CEC (cmol kg^{-1})	1.12 ± 0.02	23.45 ± 2.34	34.23 ± 2.43
Al (mg kg^{-1})	0.65 ± 0.06	49.45 ± 4.56	7.76 ± 0.87
Fe (mg kg^{-1})	0.98 ± 0.12	51.34 ± 1.32	5.76 ± 0.08
Mn (mg kg^{-1})	0.00 ± 0.00	9.45 ± 0.34	4.65 ± 0.54

The results showed that the organic C content of EFBOP reached 423 g kg^{-1}, of which 32 g kg^{-1} and 96 g kg^{-1} was in the form of carbohydrates and lignin, respectively (Table 2). The total nitrogen content in EFBOP reached 54 g kg^{-1} (Table 2), indicating that EFBOP has the potential to be a source of nitrogen in the soils. EFBOP also contains other nutrients such as Ca, Mg, N and K with nutrient content in the range of 20–54 g kg^{-1} (Table 2). The characteristics of EFBOP used in this study are in agreement with that used for OM application to improve soil characteristics of reclaimed-mining soils [31].

The CFA used in this study had a neutral pH, with low organic carbon and total nitrogen contents, reached to only 4.6 g kg^{-1} and 0.3 g kg^{-1}, respectively (Table 2). CFA also contained low amounts of phosphorous element. However, CFA contained high amounts of basic cations, where

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the total Ca and total Mg contents reached to 947 mg kg^{-1} and 1368 mg kg^{-1}, respectively (Table 2). Several previous studies showed that similar characteristics of CFA used as a soil ameliorant with CFA used in this study [32, 33].

Table 2. Chemical characteristics of empty fruit bunches of oil palm and coal-fly ash used for the experiment. Numbers after "±" indicate the standard deviation of mean (n=3).

Chemical characteristics	Empty fruit bunches of oil palm	Coal-fly ash
Organic C (g kg^{-1})	422.54 ± 9.56	4.56 ± 0.08
Total N (g kg^{-1})	54.23 ± 4.32	0.25 ± 0.10
pH H_2O	-	7.12 ± 0.76
P (g kg^{-1})	23.21 ± 2.54	2.56 ± 4.32
Ca (mg kg^{-1})	54.32 ± 3.45	947.21 ± 9.34
Mg (mg kg^{-1})	28.45 ± 2.22	1367.88 ± 7.76
K (mg kg^{-1})	23.23 ± 2.12	657.65 ± 6.54
Na (mg kg^{-1})	19.83 ± 2.12	456.45 ± 9.56
Carbohydrate (g kg^{-1})	32.43 ± 4.22	-
Lignin (g kg^{-1})	96.67 ± 8.22	-

The contents of NH_4^+ and NO_3^- in quartz sand, Palam Soil and Cempaka Soil increased with the application of EFBOP and CFA. The application of EFBOP to quartz sand (control) increased the contents of NH_4^+ from 0.10 mg kg^{-1} to 15.93 mg kg^{-1} and the contents of NO_3^- increased from 0.10 mg kg^{-1} to 15.93 mg kg^{-1} (Figure 1a). The application of EFBOB combined with CFA resulted in further increases in NH_4^+ and NO_3^- in quartz sand. The application of EFBOF and CFA to Palam Soil and Cempaka Soil also resulted in increased concentrations of NH_4^+, NO_3^- and total nitrogen minerals (Figure 1a and 1b). The contents of NH_4^+ and NO_3^- in Palam Soil increased by 169% and 151%, respectively with the application of EFBOP, and increased to 253% and 280%, respectively when EFBOP was added together with CFA (Figure 1A). The application of EFBOP on Palam Soil resulted in an increase in total mineral nitrogen from 9.77 mg kg^{-1} to 25.35 mg kg^{-1}, and increased to 35.91 mg kg^{-1} with the application of EFBOP and CFA (Figure 1B).

Increasing the contents of NH_4^+, NO_3^- and total mineral N in Cempaka Soil were greater than those in Palam Soil. The application of EFBOP on Cempaka Soil resulted in a 239% increase in NH_4^+ contents and a 222% increase in NO_3^- contents, and the contents of NH_4^+ and NO_3^- increased to 385% and 320%, respectively with the application of EFBOP and CFA (Figure 1A). Total mineral nitrogen in Cempaka Soil increased from 14.34 mg kg^{-1} to 47.05 mg kg^{-1} with the addition of EFBOP and increased to 63.59 mg kg^{-1} with the application of EFBOP combined with CFA (Figure 1B).

The increase in the amount of nitrogen in the form available for plant uptake (NH_4^+ and NO_3^-) in reclaimed-mining soils with EFBOP and CFA applications is related to the nitrogen mineralization of added EFBOP. Under ideal conditions for the decomposition process of organic matter (water contents, temperature and the availability of substrates), organic nitrogen is decomposed by soil microorganisms to produce NH_4^+, and the NH_4^+ converts through further biochemical reactions to produce NO_3^- [34, 35]. Several previous studies have shown that the rate of nitrogen mineralization is controlled by the C/N ratio of organic matter, in which high C/N ratio of organic matter does not lead to nitrogen releases onto soils [36, 37]. Therefore, several studies

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have used the parameter of C/N ratio as a threshold value for whether an organic matter would mineralize. Research conducted by Dale et al. [38] showed that the threshold value for nitrogen mineralization of organic matter is below a C/N ratio of 15, while Calderon et al. [39] suggest to use a C/N ratio of between 16 and 19 as threshold values for nitrogen mineralization. Organic matter with C/N ratios larger than 19 always experiences nitrogen immobilization, while organic matter experiencing C/N ratios lower than 14 always experiences nitrogen mineralization [39]. The EFBOP used in this study had a C/N ratio of 7.79; therefore, the presence of EFBOP in reclaimed-mining soils results in nitrogen mineralization which in turn increasing NH_4^+ and NO_3^- contents.

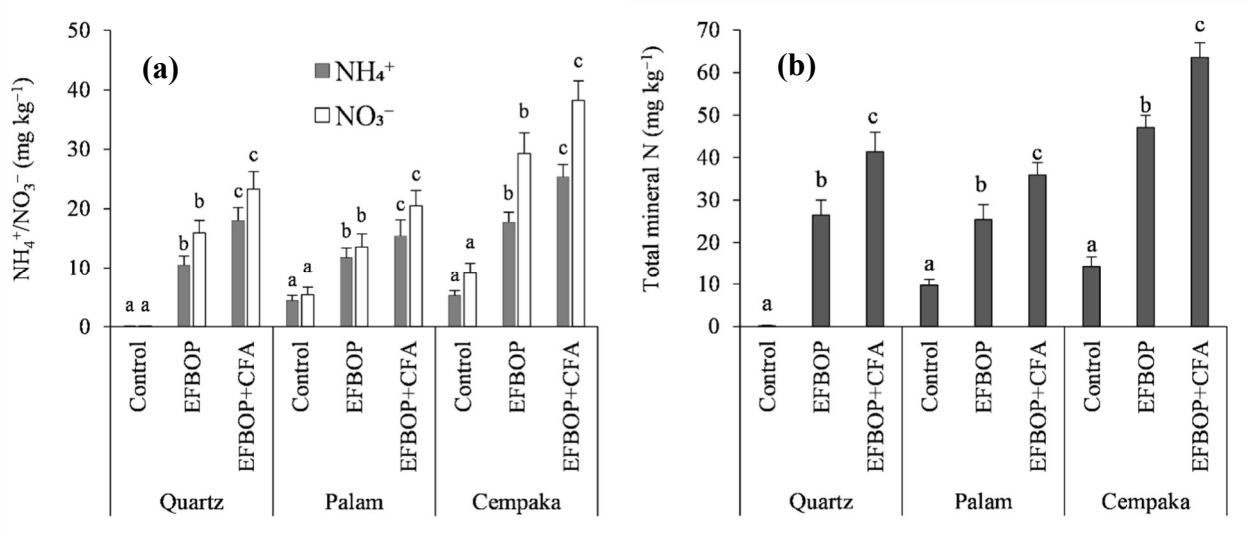


Figure 1. Changes in NH_4^+ and NO_3^- (A) and total mineral nitrogen (B) in response to organic matter (OM) and coal-fly ash (CFA) applications to two different reclaimed-mining soils. Lines above the bars represent the standard deviation of mean (n=3). Different letters above the line indicate similar effect of the treatments based on the least significance test (LSD) test at $P \leq 0.05$.

The application of EFBOP combined with CFA on reclaimed-mining soils results in significant increases in NH_4^+ and NO_3^- compared to the application of EFBOB alone. This is because the application of CFA results in an increase in soil pH of reclaimed-mining soils, which in turn results in the enhancement of microbial activity for organic matter decomposition. The results showed that the soil pH in both Palam and Cempaka Soils increased to pH 8.65–9.40 (data not shown) with the application of EFBOP and CFA. The increase in soil pH with the application of CFA is related to the dissolution and hydrolysis of basic oxides such as Ca and Mg contained in the CFA. Several previous studies have shown that the application of CFA combined with the application of organic matter increases the availability of nitrogen in the soil [40, 41].

Nitrogen mineralization of both Palam and Cempaka Soils showed different responses with EFBOP and CFA applications. Total mineral nitrogen in Palam Soil increased by 160% with EFBOF and increased by 268% with EFBOP and CFA, while the increase in total mineral nitrogen in Cempaka Soil was 228% and 344% with EFBOP and EFBOP+CFA, respectively (Figure 1B). This difference in the responses of the two reclaimed-mining soils is attributed to the differences in soil characteristics between both soils. Palam Soil had a lower soil pH and higher Al and Fe content than Cempaka Soil (Table 1). The results also showed that the soil pH in Palam Soil

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increased from pH 2.37 to pH 3.38 with the application of EFBOP and increased to pH 8.65 with the application of EFBOP and CFA (data not shown). EFBOP application on Cempaka Soil increased soil pH from pH of 3.66 to pH of 7.73, and increased to pH 9.40 with application of EFBOP and CFA (data not shown). This difference in soil pH changes may result in different responses in nitrogen mineralization of both soils following the application of EFBOP and CFA. Several previous studies have shown that soil pH is an important environmental factor controlling the rate of nitrogen mineralization [42-44]. The results showed that the application of EFBOP and CFA increased nitrogen mineralization, in which the degree of nitrogen mineralization is controlled by soil characteristics.

Conclusion

The results showed that the application of empty fruit bunch of oil palm (EFBOP) increased the NH_4^+ and NO_3^- contents in both reclaimed-mining soils. The application of EFBOP combined with the application of coal-fly ash (CFA) resulted in further increases in the contents of NH_4^+ and NO_3^- in reclaimed mining soils compared to those with the application of EFBOP only. The greater increases in soil pH with EFBOP and CFA applications in Cempaka Soil than that in Palam Soil may ascribe to larger nitrogen mineralization in Cempaka Soil than that in Palam Soil. These results imply that nitrogen mineralization in the reclaimed-mining soil incerases with the application of EFBOP and CFA with the degree of nitrogen mineralization is regulated by the soil characteristics of reclaimed-mining soils.

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Identification and anti-cancer activity of polar isolates leaf of coffee parasite (*Scurulla ferruginea (roxb. ex jack*) danser

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Abstract. *This study aims to determine the potential for polar isolates from the leaves of the coffee parasite scurulla ferruginea (Roxb. Ex Jack) Danser as a natural anticancer. Based on the results of the isolation of leaf polar extracts, it was found that most of them contained flavonoids. Identification of compounds in polar isolates using FT-IR revealed that the flavonoid derivatives found were catechins and quercetin. The isolate activity test against HeLa cervical cancer cells and MCF-7 breast cancer cells resulted in IC_{50} values of 1,366.67 µg/mL and 1.997,50 µg/mL, respectively.*

Keywords : coffee parasite, anticancer, isolation, polar isolates, flavonoid.

Introduction

One of the parasitic plants that have an important role as a medicine is the parasite attached to coffee,which is the *Scurrula ferruginea Danser species*. Researchers reported that the leaf extract of coffee parasite has a high antioxidant content [1,2]. In particular, researcher stated that the extract of the coffee bean parasite showed extraordinary level of antioxidant properties and moderate level of antibacterial activity against gram-positive and gram-negative bacteria. Parasite coffee leaves have been shown to have immunomodulatory properties, anti-inflammatory, antidiabetic, antimicrobial, antihypertensive, antioxidant, antidiarrheal, and hypolipidemic activities [3].

Anti-bioactivity test on coffee parasite leaves has not obtained satisfactory results. Antibacterial activity test result of the disc diffusion method with an extract concentration of 1% against *Staphylococcus aureus, Salmonella typhi, Streptcoccus viridans, Escherichia coli, Streptococcus mutans, and Bacillus aureus bacteria* showed the moderate level of ability to inhibit bacterial growth. Based on the activity test results using the microdilution method, the MIC and MBC values showed that the leaf extract of the coffee parasite plant was only as an inhibitor. The results of the antibacterial activity of the parasite coffee leaf against three bacteria using the disc diffusion

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method for *S. viridians, S. mutans* bacteria were also included in the "moderate" level. Activity test using microdilution method of MIC value also showed only as inhibitory properties [4].

Previous researcher has succeeded in isolating natural flavonols from the ethyl acetate fraction of *Scurrula ferruginea Danser (Loranthaceae*) namely quercetin and quercitrin, flavonol glycosides 4 -O-acetylquercitrin. Flavonoid compounds that have been isolated from coffee parasites are linamarin gallate, walsurside B, catechins, epicatechins, epicatechin 3-O-gallate, epicatechin 3-O-(3-O-methyl) gallate, epicatechin 3-O-(3,5 -O-dimethyl) gallate, epicatechin 3-O-(3,4,5-O-trimethyl) gallate, quercetin 3-O-β-D-glucopyranoside, rutin, peltatoside, -(-) catechin-7-O- rhamnoside, catechin-3-O-rhamnoside and 4'-methoxy-catechin-7-O-rhamnoside [1,5].

Flavonoid compounds are known to have many functions for human health such as antioxidant, anti-inflammatory, antivirus, antibacterial, and others. Flavonoids represent various types of compounds found in nature. Quercetin itself is generally well known in the pharmaceutical world. Some researchers found that quercetin has antimicrobial, antiviral, anticancer, antioxidant, anti-melanogenic and anti-inflammatory [6-9]. For this reason, in this study, the polar fraction of the parasite coffee leaf was isolated, and its bioactivity was tested against cancer cells.

Methodology

Materials

Leaves of the coffee plant parasite *Loranthus Parasiticus (L.) Merr*. from Sidikalang District, Dairi Regency. N-hexane, ethyl acetate, aquadest, silica gel 60 GF254, methanol, ethanol, microtube, tube, T-flask, Cisplatin, Dimethyl sulfoxide (DMSO), Phosphate buffered saline (PBS), 9. PrestoBlue™ Cell Viability Reagent, Roswell Park Memorial Institute Medium (RPMI), Fetal Bovine Serum (FBS), Trypsin-EDTA, Trypan Blue.

Methods

The process of extracting the active compounds from the leaves of the coffee plant parasite is performed with the maceration method using methanol as solvent**.** The thick extract of the plant Loranthus parasiticus L. Merr was separated using Vacuum Liquid Chromatography (VLC). For the isolation of secondary metabolites, the separation by Column Chromatography used silica gel 60 F254 (0.040-0.063 mm as the stationary phase) with N- Hexa:Ethyl Acetate (1:1) and ethyl acetate:methanol (1:1) as eluents.

For the anticancer test, the cell culture to be used was placed in a 96 well plate and then incubated (at 37°C and 5% CO_2 gas until the percentage of cell growth reached 70%). Cells were sampled and then incubated (for 48 hours at 37°C and 5% CO_2). Presto blue reagent was added to the cells. Absorbance measurement using Multimode Reader.

Results and discussion

The separation of the active compounds contained in the parasite leaves was carried out in 2 steps; the phase of fractionation of polar compounds by liquid Vacuum Liquid chromatography (VLC) and isolation using Gravity Column Chromatography (GCC). The methanol extract of the leaves of the coffee plant parasite was eluted with the eluents of N- hexane:ethyl acetate and Ethyl Acetate:Methanol in various ratios. Furthermore, TLC results showed a single stain in the F7 and F15 fractions, then the isolates were identified by FTIR and NMR.

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Identification of the structure of polar isolate compounds using the FT-IR instrument (Figure 1) aims to analyze the types of compounds contained in the isolates based on functional groups. The identification result for the first isolate, it was found a wide absorption in the 3322 cm $^{-1}$ which is thought to be absorption from the OH group. In the area of 2944 cm $^{-1}$ sharp band and weak intensity indicated the presence of aliphatic CH groups. In the area of 1448 cm^{-1} sharp bands indicate the presence of a C=C group (aromatic ring). Moreover, the area of 1113 cm^{-1} shows the absorption of the C-O-C group and in the area of 1020 cm $^{-1}$ shows the absorption of the C-C group. The IR spectrum of the polar isolate of the coffee parasite leaf shows in Figure 1.

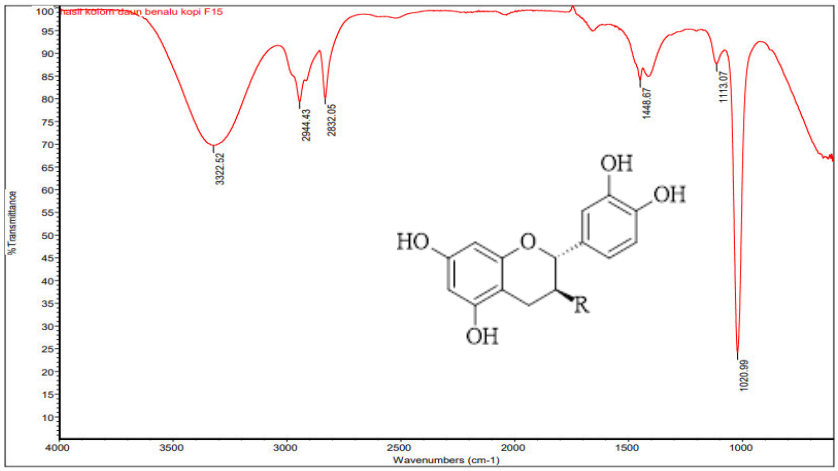


Figure 1. IR Spectrum of polar isolate leaf parasite coffee (*Lornthus parasiticus* (L.) *Merr* .)

Based on spectrum data, it can be concluded that the compounds contained in the polar isolate F_{15} of the leaves of the plant *Loranthus parasiticus* (L.) *Merr.* It is suspected contains catechin-type flavonoid compounds based on previous research [11] which has the same IR spectrum as the results obtained in the coffee parasite leaf as shown in Figure 2 .

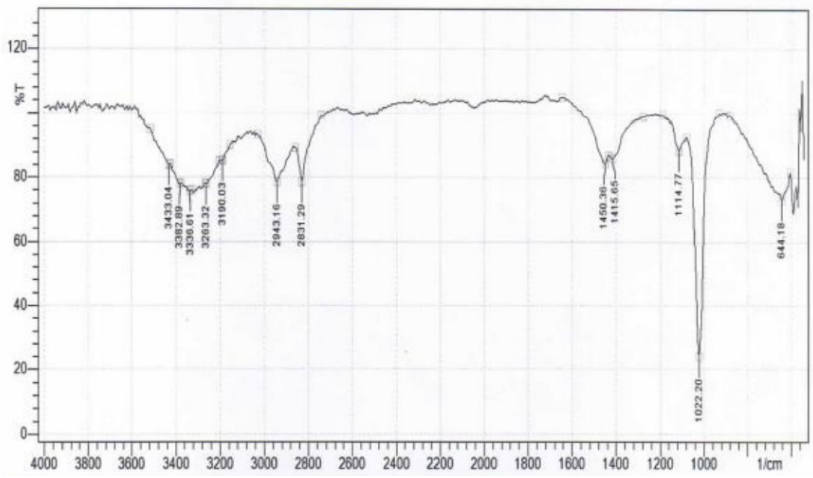


Figure 2. IR Spectrum of the nusa indah bunga ethyl acetate fraction [11].

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The results of the identification for the second isolate formed a wide absorption in the 3331 cm^{-1} area which was thought to be absorption from the O-H group that indicate contained an OH group. There is a C-H bond at 2946 cm $^{-1}$ and absorption at wave number at 1410 cm^{-1} indicating the C-C sp2. Absorption group at a wavelength of 800 cm^{-1} showed the presence of substituted benzene. Absorption at a wavelength of 1648 cm^{-1} indicates the presence of a carbonyl group (C=O). The absorption at 1307 cm^{-1} and the fingerprint region at wave number 1016 cm^{-1} indicate the absorption of the C-O functional group. The IR spectrum of the polar isolate of the coffee parasite leaf can be seen in Figure 3.

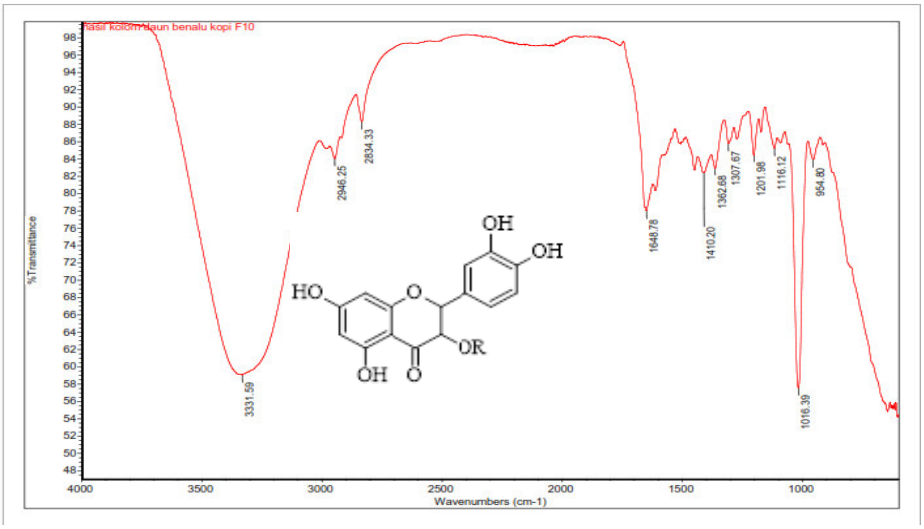


Figure 3. IR Spectrum of parasite coffee leaf isolate *(Loranthus parasiticus (L.) Merr.)*

Based on the spectral data, it can be concluded that the compounds contained in the two polar isolates of the leaves of the plant *Loranthus parasiticus* (L.) *Merr.* it is thought to be a quercetin-type flavonoid compound. The IR spectrum of isolates on the leaves of parasitic flavonoid compounds from the tea parasite plant (*Scurulla arthropurpurea*) has similarities with the IR spectrum of quercetin research that has been carried out by previous research [11].

The presence of catechin and quercetin compounds as flavonoid derivatives in coffee parasite was strengthened through the ^{1}H-NMR spectrum as shown in Figure 4. The presence of a proton peak of C sp2 (=CH-) δH 6.228; 6.411; 6.97; 7.367; 7.381 and 7.9 ppm. Protons at δH 6.228; 6.411 and δH 7.9 are singlet and at δH 7.367; 7.381 ppm is doublet, this indicates that the positions of these protons are meta to each other in ring A, while in ring B there is an ortho position with each other. The presence of a shift of C sp3 (CH_2 -) at a shift of about 1 to 2 ppm indicates that this isolate is closer to the structure of catechins. And peaks at shifts of 3 to 4.4 ppm allow for the presence of a glucose structure. In other words, this ^{1}H-NMR spectrum characterizes the spectrum for a-(-) Catechin-7-O-rhamnoside compound. However, the data were not supported by ^{13}C-NMR, because of the limited number and degree of purity of the isolates, identification could not be continued.

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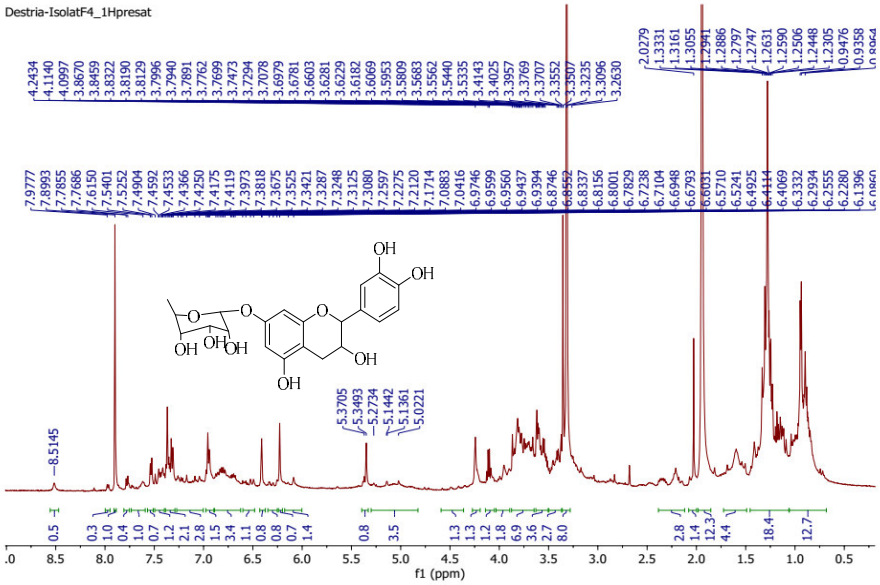


Figure 4. Spectrum of ^{1}H-NMR isolate of leaf parasite coffee *(Loranthus parasiticus (L.) Merr.)*

Extract activity studies were followed by cytotoxicity studies against HeLa cervical cancer cells and MCF-7 breast cancer cells. The IC_{50} value indicates the concentration level that inhibits cell proliferation by 50% and indicates the compound's cytotoxic potential. The higher the IC_{50} value, the less toxic the compound.

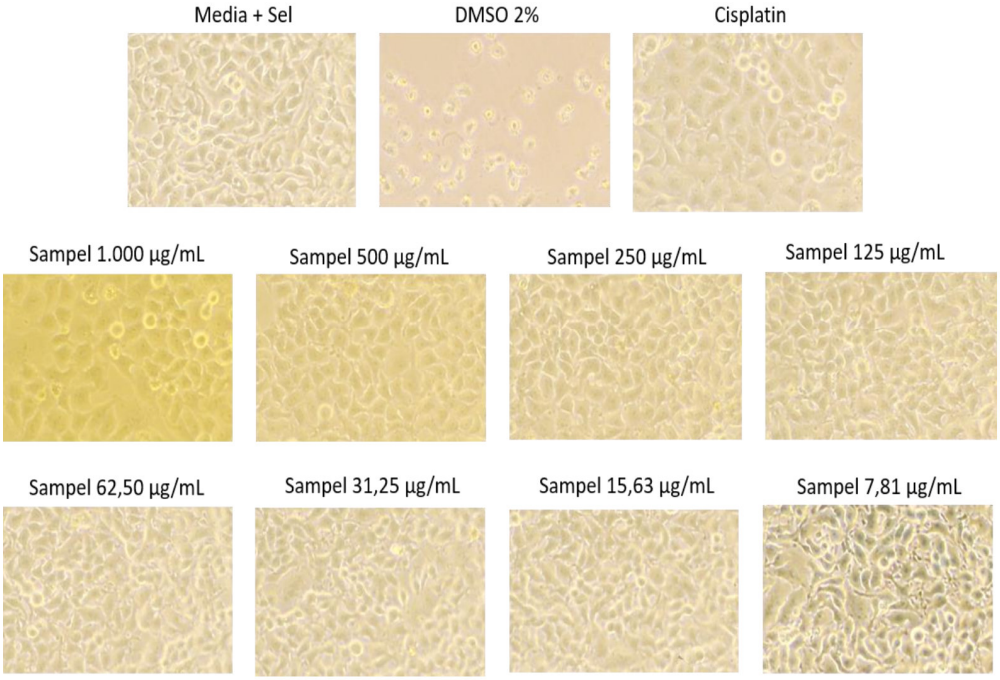


Figure 5. Test result of HeLa cell morphology F14

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Toxicity test of coffee parasite extract on HeLa cervical cancer cells in Figure 5 and MCF-7 breast cancer cells in Figure 6 resulted in IC_{50} of 1,366.67 g/mL and 1,997.50 g / mL, respectively. These results indicate that the isolates of coffee bean parasite at this concentration were able to kill HeLa cells and MCF-7 breast cancer cells by 50% of the initial population. Based on the NCI (National Cancer Institute) standard, a compound is said to have the potential to be further developed as an anticancer if it has an IC_{50} value of 20 g/mL. Thus, it can be concluded that the coffee parasite isolate was able to inhibit the growth of HeLa cells but lacked potential as an anticancer agent. Based on The National Cancer Institute (NCI) the IC_{50} value of this coffee parasite extract is classified as weak or inactive [12].

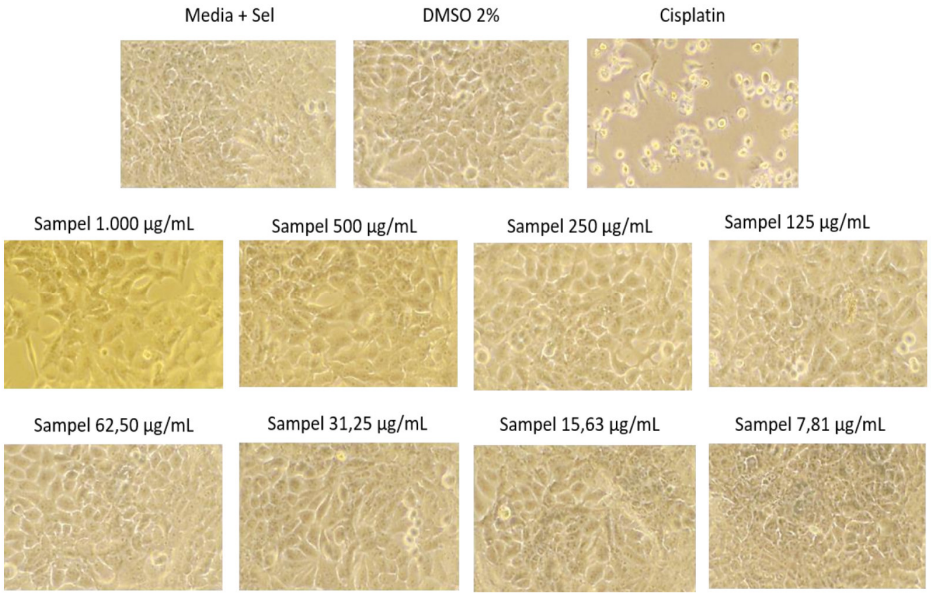


Figure 6. Test result of MCF-7 cell morphology F14

Conclusion

The results of the isolation of secondary metabolites from the identification by IR showed that the isolate was catechin and was strengthened by the ^1H NMR spectrum, indicating that the compound was a spectrum for the compound a-(-) Catechin-7-O-rhamnoside. Moreover, quercetin-type flavonoid compounds were also found, but it could not be confirmed by NMR spectra because there were still a few impurities in the isolate. These two coffee parasite isolates had IC_{50} values of 1.366.67 g/mL and 1.997.50 g/mL, respectively, which means they are not active against HeLa cervical cancer cells and MCF-7 breast cancer cells.

Acknowledgments

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Synthesis of silica coated nanomagnetite ethylene diamine tetra acetic acid functionalized

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ABSTRACT. EDTA functionalized silica-coated nano magnetite has been synthesized. Nano magnetite is produced by co-precipitation. Silica is isolated from beach sand. Nano magnetite is coated with silica, then 3-aminopropyl triethoxysilane (APTES) is bonded to the silica layer, and ethylene-diamine-tetra-acetic-acid (EDTA) is bonded to APTES. The characteristics of the synthesized material were analyzed based on the spectral patterns of the FTIR spectrum, XRD diffractogram, SEM morphological images, and magnetic strength measured by VSM. The results showed that the average particle size of the synthesized Fe3O4 was 78 ± 3 nm. The result of the synthesis is nano magnetite coated with EDTA functionalized silica. After being coated the particle size is 219,9 nm and the magnetization value is 55 emu/g.

Keywords: Nanomagnetite, Silica coated nanomagnetite, SiO_2, Pb(II), Cu(II)

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1. Introduction

Magnetic solid phase extraction (MSPE) is a separation technology by adsorption method, using a solid phase coated on a magnetic material. MSPE offers practicality in separating the adsorbent from the matrix, the adsorbent is mixed with the matrix and can be attracted using a magnetic field, leaving the matrix. Various modification methods have been developed to obtain the specific properties and functions of nanomagnetite as an adsorbent[1].

Nanomagnetite coating on EDTA functionalized silica is one of the results of the modification of nanomagnetite which is intended to bind specific metal ions. In this research, a functionalized silica-coated nanomagnetic adsorbent synthesized by EDTA (NMSiEDTA) was synthesized, silica isolated from beach sand was used, and its physicochemical properties were characterized. EDTA on the surface of the adsorbent becomes a metal ion binder, and metal ion binding can be carried out specifically[2], because the EDTA-metal ion complex occurs at a specific pH, for each type of metal ion.

2. Experimental

2.1 Materials

All chemicals were of analytical grade and used as received without further purification. Ferrous sulfate heptahydrate ($FeSO_4.7H_2O$), ferric chloride hexahydrate ($FeCl_3.6H_2O$), ammonium hydroxide (NH_4OH), ethanol (C_2H_5OH, 96%), acetic acid anhydride (CH_3COOH), 3-aminopropyl triethoxysilane (APTES), ethylene diamine tetra acetic acid (EDTA), and hydrochloric acid (HCl, 37%) was obtained from Merck Chemicals co. Silica was synthesized from sand in Ungapan Beach. All aqueous solutions were prepared with distilled water.

2.2 Instrumentation

Scanning Electron Microscope (SEM) to describe the particle size and morphology. Fourier transform infrared (FT-IR) spectra were measured between 4000 and 400 cm^{-1}. The X-Ray Diffraction data were collected using an X-Ray Diffractometer (XRD). A vibrating sample magnetometer (VSM) was used to obtain magnetization results.

2.3 Iron Oxide Magnetic Nanoparticles Preparation

1.73 and 3.37 grams of $FeSO_4.7H_2O$ and $FeCl_3.6H_2O$ were dispersed in 50 mL of distilled water, and the two solutions were mixed and heated to 90℃. The mixture of $FeCl_3$(aq)-$FeSO_4$(aq) was reacted with NH_4OH(aq) while stirring. The precipitate obtained is filtered, neutralized, then dried. The results of the synthesis of nanomagnetite (Fe_3O_4) were observed for their morphology (SEM) and analyzed for their functional groups (FTIR), crystallinity (XRD), and magnetization (VSM).

2.4 Synthesis and Characterization of Silica made from Ungapan Beach Sand

Ungapan beach sand was washed with distilled water and dried for 12 hours at 60°C. Clean sand was soaked in 2 M HCl solution for 12 hours, washed until neutral, and dried at 60 °C. 15 grams of washed beach sand was refluxed in 3 M NaOH solution for 4 hours at 90°C and then filtered, the filtrate was added to 6 M HCI solution, until a gel was formed, then allowed to stand for 18 hours. The gel formed was filtered and washed using distilled water and dried in an oven at 80-100 °C for 2-3 hours. The dry gel was crushed and sieved to form silica powder[3]. Silica powder was characterized using X-Ray Fluorescence (XRF), Fourier Transform Infra-Red (FTIR), and X-Ray Diffraction (XRD) instruments.

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2.5 Preparation of Silica Coated Iron Oxide Nanoparticles

1 g Fe_3O_4 was dispersed in 200 ml EtOH/H_2O 85:15, then 15 ml NH_4OH(aq) and 3 ml silica gel were added. Stir the mixture for 2 hours, then sonicate for 10 minutes. The coating process was repeated three times. The results of the synthesis of Fe_3O_4@SiO_2 were washed with alcohol until neutral and dried. The resulting Fe_3O_4@SiO_2 was characterized using FTIR, SEM, and VSM instruments.

2.6 Functionalization with amino and carboxyl group

0.5 g Fe_3O_4@SiO_2 nanoparticles in 100 ml of EtOH/H_2O solution with a ratio of 85:15. dispersed in a solution of pH 4.5 (pH adjusted with 0.1 M HCl solution) then sonicated for 10 minutes and 3.5 ml of APTES was added with a few drops of acetic anhydride. Then the mixture was refluxed at 60℃ for 4 hours. The particles were separated from the liquid using an external magnet and rinsed with water and acetone once each. Furthermore, the washed nanoparticles were dispersed in 0.3 mol/L EDTA solution, then the mixture was refluxed at 60℃ for 2 hours. The nanoparticles were then separated from the dispersion and dried at 50℃ for 120 minutes. This process produces Fe_3O_4@SiO_2-COO.

3. Results and Discussion

3.1 Synthesis of Nanomagnetite

Nanomagnetite synthesis by coprecipitation. Fe^{2+} and Fe^{3+} solutions were reacted with ammonia solution. The reaction that occurs is as follows:

$$Fe^{3+} + 3OH^- \rightarrow Fe(OH)_3 \quad (1)$$
$$Fe(OH)_3 \rightarrow FeOOH + H_2O \quad (2)$$
$$Fe^{2+} + 2OH^- \rightarrow Fe(OH)_2 \quad (3)$$
$$2FeOOH + Fe(OH)_2 \rightarrow Fe_3O_4\downarrow + 2H_2O \quad (4)$$

It produces dark black Fe_3O_4 powder which is then analyzed for its characteristics.

3.2 Synthesis of Silica from Ungapan Beach Sand

Ungapan beach sand was washed with distilled water, dried, and then soaked in HCl for 12 hours to remove the components other than SiO_2 in the sand as much as possible. Furthermore, the sand is washed using distilled water until neutral and then dried in the oven. The sand was then dispersed in a 3M NaOH solution. NaOH dissociates into sodium ions (Na^+) and hydroxyl ions (OH^-). The hydroxyl ion as a nucleophile attacks the Si atom in the electropositive SiO_2, then the electronegative O atom breaks one of its double bonds and forms a SiO_2OH^-. Then the H^+ will be released to form SiO_3^{2-} which binds to 2 Na^+ to become Na_2SiO_3. The following is a chart of the reaction mechanism:

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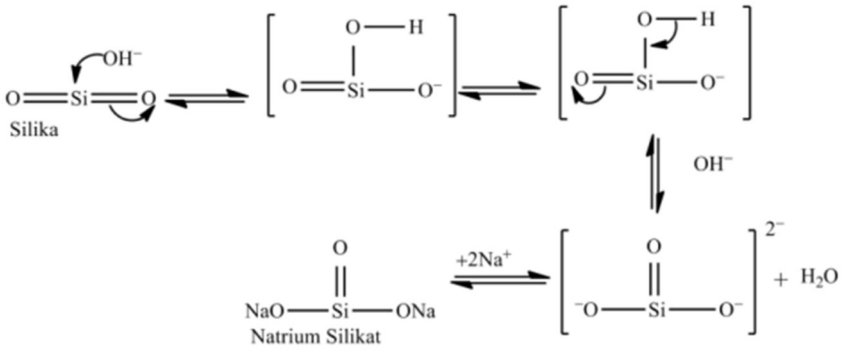


Figure 1. The Mechanism Reaction of Sodium Silicate

The reaction mixture containing Na_2SiO_3 is filtered and the filtrate is added to 6M HCl solution until neutral. Na^+ is exchanged by H^+ to produce silicic acid. The protonation of a siloxy group (Si-O-) to a silanol group (Si-OH) is caused by the addition of HCl. The silanol groups that have been formed will react with the siloxy groups if acid is added continuously. The result of this reaction is the formation of siloxane (Si-O-Si). The following is the mechanism of the reaction:

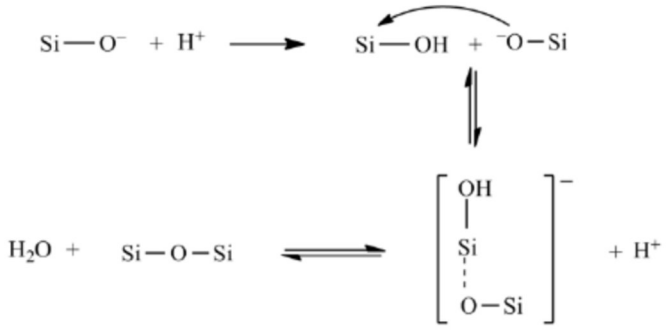


Figure 2. Silica Gel Reaction

The result of the synthesis is a white precipitate of silica gel. The silica gel was dried in an oven and analyzed for the types of functional groups and their crystallinity.

3.3 Synthesis of Silica Coated Iron Oxide Nanoparticles

Nanomagnetite is coated with silica resulting from synthesis to produce nanomagnetite coated with silica. The coating was carried out three times, and the result of the synthesis was in the form of brownish-black powder which could be attracted by a magnet. Characterization was carried out to see the morphology, magnetic properties, and functional groups of nanomagnetite that had been coated with silica.

3.4 EDTA Functionalized

EDTA functionalization was carried out by binding EDTA to the silica layer through 3-Aminopropyl triethoxysilane (APTES) as an intermediary. The surface of the silica-coated nanomagnetite has siloxane groups (Si-O-Si) and silanol groups (Si-OH) on its surface. The

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reaction with APTES exchanged silanol hydroxyl groups with alkoxide groups (OC_2H_5). The silanol groups also interact with other silanol groups to form siloxane bonds (Si-O-Si) and produce silane polymers. EDTA is bound to APTES through a covalent bond between the EDTA carboxylic acid group and the APTES amino acid group. The reaction mechanism for the formation of EDTA functionalized silica-coated nanomagnetite can be seen in the following illustration[2]:

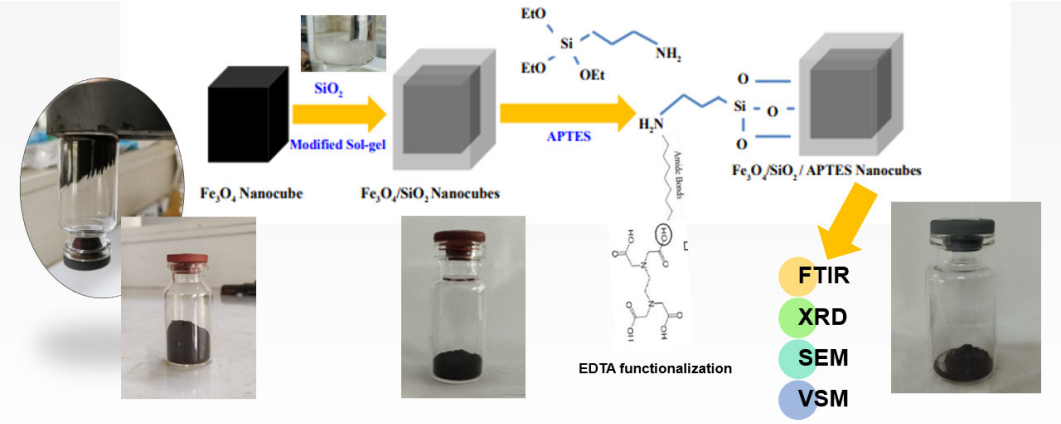
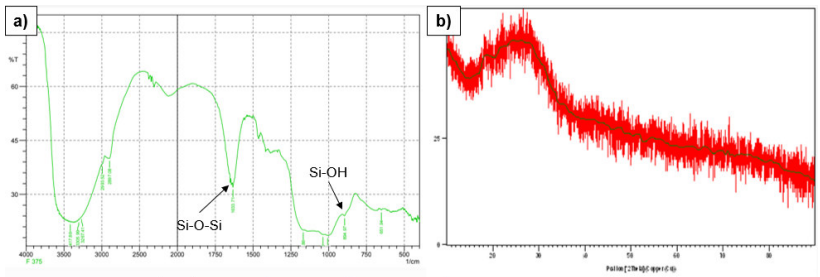


Figure 3. Fe_3O_4@SiO_2 with EDTA Functionalized

The resulting adsorbent was then characterized to see its functional groups, crystallinity, morphology, and magnetic properties.

3.5 Characterization

Silica synthesized from Ungapan Beach, Malang was characterized to determine its functional groups, crystallinity, and silica content. The results of the characterization of silica from Ungapan Beach are shown in the figure below:



c)

CaO	SiO2	Fe2O3	Other compounds
51,7%	23,1%	16,1%	9,1%

Figure 4. a) FTIR Spectra for Silica b) Diffratogram of Silica c) XRF of sand from Ungapan Beach

Based on FTIR spectrum analysis, there are Si-O-Si absorption bands at wave number 1037.7 cm^{-1} and Si-OH at wave number 894.97 cm^{-1}. The silica diffractogram shows intensity peaks identical to typical silica peaks at 22.1°. The XRF results of Ungapan Beach sand showed a SiO_2 content of 23.1%.

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The FTIR spectrum of nanomagnetite before coating, after coating, and after EDTA binding is shown in the figure below:

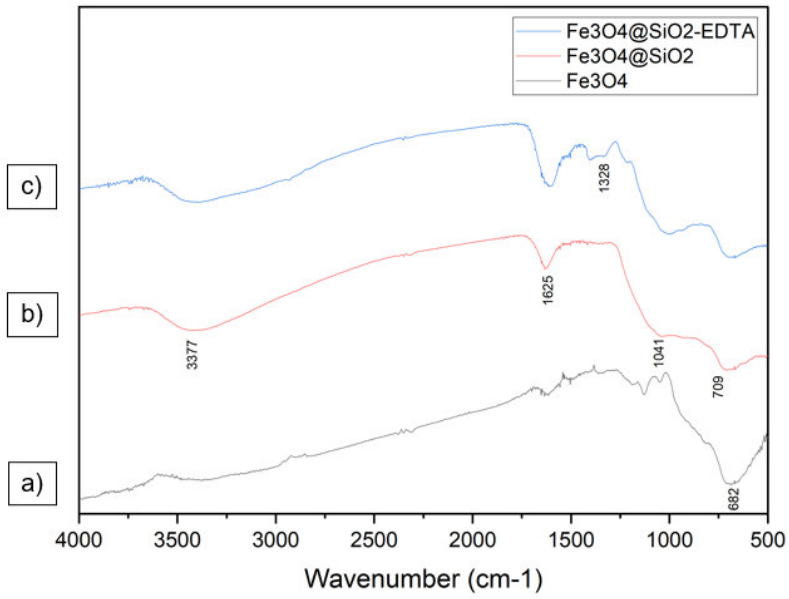


Figure 5. FTIR Spectra of a) Fe_3O_4 b) Fe_3O_4@SiO_2 c) Fe_3O_4@SiO_2-EDTA

Based on the FTIR spectrum there are differences in functional groups between the three spectra. The formation of Fe_3O_4 was confirmed by the presence of a Fe-O absorption band at a wavelength of 682 cm^{-1} which can be seen in spectra a). The FTIR spectra after coating with silica are shown in curve b) where the absorption bands of 709 cm^{-1} and 1041 cm^{-1} indicate Si-O-Si, Si-OH, and Si-O groups. The spectrum of EDTA functionalized silica-coated nanomagnetite showed an absorption band of 1625 cm^{-1} correlating with C=O of the EDTA carboxyl group, while an absorption band of 1407 cm^{-1} confirmed the presence of an amine group from APTES, an absorption band at around 1400 cm^{-1} which confirmed the amine group of APTES was also suggested by previous researchers[4].

The crystallinity of the synthesized results, analyzed by X-Ray Diffractometer (XRD) and shown in Figure 6, shows typical peaks that are identical to the specific peaks of nanomagnetite, namely peaks of 30.2°, 35.5°, 43.2°, 57.1 °, 62.7°, and 74.2°. The characterization results were compared with the typical peaks of the EDTA functionalized silica-coated nanomagnetite diffractogram, the typical peaks appear to be identical but experience a slight shift, namely 30.2°, 35.6°, 43.3°, 53.6°, 57.3°, and 62.9°, high-intensity peaks appear 35° which is identical to silica, the peak of 53.6° is the peak that appears after the functionalization process with EDTA, indicating the peak of the amine group.

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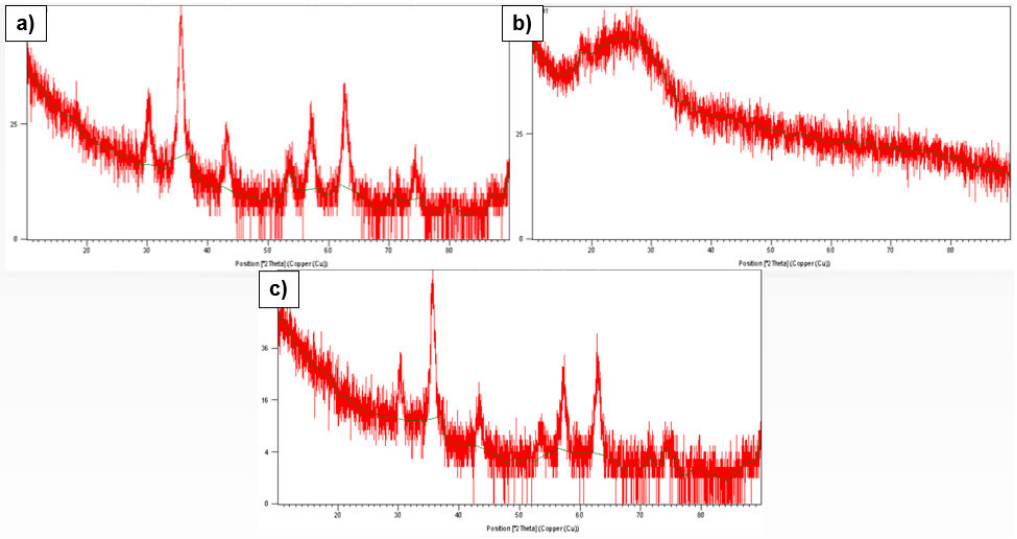


Figure 6. a) Diffractogram of Fe_3O_4 b) Diffractogram of Fe_3O_4@SiO_2 c) Diffractogram of Fe_3O_4@SiO_2-EDTA

The morphology of Fe_3O_4 and Fe_3O_4@SiO_2-EDTA was characterized by Scanning Electron Microscopy (SEM), the results are shown in Figure 7 below:

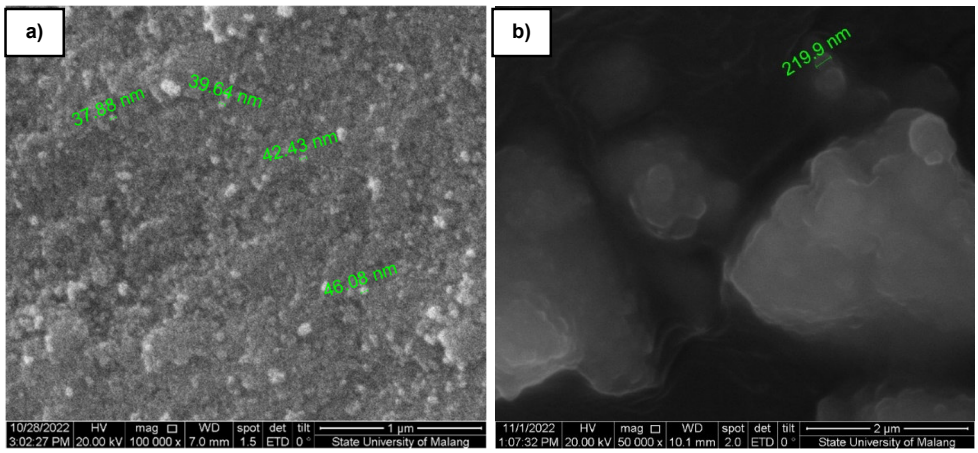


Figure 7. a) Morfology of Fe_3O_4 b) Morfology of Fe_3O_4@SiO_2-EDTA

Synthesis of Fe_3O_4@SiO_2-COO produces a particle size of 219.9 nm which is larger than the nanomagnetite particle size.

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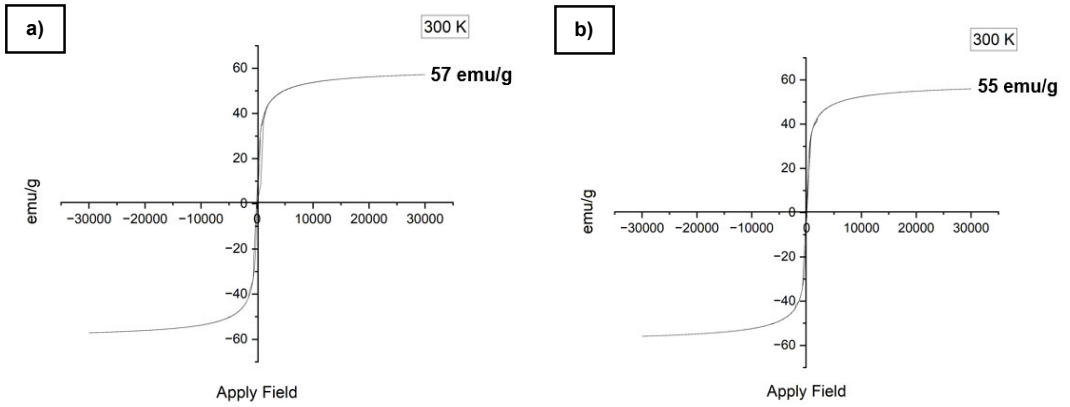


Figure 8. a) Magnetization of Fe_3O_4 b) Magnetization of Fe_3O_4@SiO_2-EDTA

After coating and functionalization with EDTA, the magnetization of nanomagnetite and nanomagnetite was characterized using a Vibration Sample Magnetometer (VSM). the magnetization of nanomagnetite decreased after coating, before coating the magnetization value was 55 emu/g from 57 emu/g.

4. Conclusions

EDTA functionalized silica-coated nanomagnetite has been synthesized. Analysis of the FTIR spectrum, XRD diffractogram, and morphology showed that silica coating, APTES binding, and EDTA functionalization had occurred on the synthesized nanomagnetite. The average particle size of silica-coated nanomagnetite EDTA functionalized is 219.9 nm and the magnetization value is 55 emu/g.

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Silica coated nanomagnetite as crystal violet dye adsorbent

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Abstract. *Silica is one of the adsorbents that can be used in the adsorption of dyes. Silica can be synthesized from natural materials, one of which is beach sand. This study used sand from Ungapan Beach, Malang Regency as a silica synthesis material. In this research, the synthesis of silica coated nanomagnetite as an absorbent dye was carried out. Nanomagnetite was synthesized using the coprecipitation method by reacting a mixture of 0.125 M $FeSO_4.7H_2O$ solution and 0.25 M $FeCl_3.6H_2O$ solution with 0.5 M NaOH. The characterization of silica coated nanomagnetite was carried out using X-Ray Difraction (XRD), Scanning Electron Microscopy (SEM), and Fourier Transform Infrared Spectroscopy (FTIR) instruments. The silica coated nanomagnetite XRD diffractogram shows a peak with high intensity at an angle of 2 θ from 35° and a dilation of the peak at a 2θ angle of 21-23° . The morphological analysis of the material showed that the size of the surface diameter of silica coated nanomagnetite averaged 73 nm. FTIR spectrum analysis of adsorbent material confirmed the presence of Si-O-Si bonds, indicated by the absorption peak at a wavelength of 1031.92 cm^{-1} and Fe-O bonds indicated by absorption at a wavelength of 416.62 cm. The adsorption capacity of the adsorbent against crystal violet is 0.0089 mg of crystal violet for 1 gram of each adsorbent. The adsorption of crystal violets with silica coated nanomagnetite adsorbents followed the Langmuir isotherm curve pattern.*

Keywords : Silica coated nanomagnetite, adsorption, textile dye, beach sand, crystal violet.

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Introduction

Textile dyes are also materials that generally have carcinogenic properties [1]. One type of textile dye that is often used is crystal violet. Crystal violet or hexamethyl pararosaniline chloride is a cationic dye that is widely used as a textile dye. Crystal violets have a complex structure that is difficult to remove [1]. Crystal violet levels in the aquatic environment have a threshold of 0.002 ppm allowed. Silica or SiO_2 is a compound commonly used as an adsorbent or substance that absorbs in the adsorption process. Silica is effective in reducing the content of dyes but is easily dispersed in water so that the separation process takes a long time.

Nanomagnetite is a Fe_3O_4-based nanoparticle. Magnetite or $Fe_3O_4$is a black powder that is non-toxic so it is widely used in various applications [2]. Coated nanomagnetite adsorption offers magnetic adsorption where adsorbents can be drawn from the matrix using an outer magnetic field can be used as an attractive alternative [3]. Sea sand can be processed into silica [4] as an economical and always available silica synthesis solution. Ungapan Beach is one of the beaches in Malang Regency. Ungapan Beach is located in Gajahrejo Village, Gedangan District, Malang Regency. Silica coated nanomagnetite is produced with silica synthesized from beach sand. Beach sand in addition to containing silica also contains several other metal oxides. However, in this study, we conducted purification to obtain the highest level of silica. Nanomagnetite is produced by the method of coprecipitation.

Methodology

Materials

The materials used in this study were $NaOH_{(s)}$, $FeSO4.7H_2O_{(s)}$, $FeCl_3.6H_2O_{(s)}$, 37% HCl, distilled water, and crystal violet.

Equipments

The equipment used in this study is a spray bottle, magnetic stirrer, *hot plate*, mortar and pestle, 100 mesh sieve, analytical balance, oven, aluminum foil, universal indicator, sereflux device device, buchner, desiccator, filter paper, set of glassware, stative and clamps, X-Ray *Fluorescence* (PanAnalytical brand, type: Minipal 4), *X-Ray Diffraction* (PanAnalytical brand, type: E'xpert Pro), *Fourier Transform Infra Red* (Shimadzu brand type: IRPrestige 21), *Scanning Electron Microscopy* (Brand FEI type: Inspect-S50), and *Visible Genesys* 20 spectrophotometer.

Synthesis and characterization of nanomagnetites

$FeSO_4.7H_2O$ 0.125 M solution was mixed with 0.25 M $FeCl_3.6H_2O$ solution in a ratio of 1: 1, added gradually dropwise into 0.5 M NaOH solution with stirring using a magnetic stirrer for 30 minutes. The black precipitate formed was filtered using distilled water to a neutral pH of 7. The precipitate was dried in an oven at 50-60 °C for 5 hours. The solids obtained were ground using a mortar and pestle and then sieved

Synthesis and characterization of silica from beach sand

The sand of Ungapan Beach that has been taken is cleaned first by washing it with distilled water and dried overnight at a temperature of 60°C. The drying results were then soaked with 2 M HCl

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solution for 12 hours. Then washed until neutral and dried overnight at 60°C. The washed beach sand was then refluxed in a 3 M NaOH solution for 4 hours at a solution temperature of 90°C.

The filtrate obtained was then added with 6 M HCl solution to pH 7 to form a gel and allowed to stand for 18 hours. The gel formed was then filtered and washed using distilled water and dried in an oven at 80-100°C for 2-3 hours. The results of drying are then ground and sieved to form silica powder.

Synthesis and characterization of silica coated nanomagnetite

The obtained silica gel was decanted to reduce fluid levels. Then silica gel was mixed with nanomagnetite synthesis results in a ratio of 1: 1. The mixture was stirred after which it was filtered. The filtering results were washed with distilled water and then filtered and dried at 60-70°C for 3 hours. The drying results are then grinded and sieved.

Adsorption of crystal violet dyes with silica coated nanomagnetite adsorbent and adsorbation value measurement

The maximum wavelength was determined. The absorbance of crystal violet was measured at a concentration of 0.3 ppm at a wavelength between 585 to 595 nm. A crystal violet calibration curve was made. The absorbance of crystal violet was measured with a concentration of 0.10; 0.15; 0.20; 0.25; 0.30; 0.35; and 0.40 ppm at the maximum wavelength of crystal violet.

Prepared 25 mL of crystal violet solution with a concentration of 0.25 ppm into the Erlenmeyer added as much as 0.4 g of silica coated nanomagnetite adsorbent. The mixture was stirred using a shaker for 120 minutes. Then the adsorbent is separated by using an external magnetic field. The adsorption filtrate was measured for its absorbance. Then it was repeated with a variation of the adsorbent mass of 0.5; 0.6; 0.7; and 0.8 grams.

Prepared 25 mL of crystal violet solution with a concentration of 0.25 ppm into the Erlenmeyer added as much as 0.5 g of silica coated nanomagnetite adsorbent. The mixture was stirred using a shaker for 120 minutes. Then the adsorbent is separated by using an external magnetic field. The adsorption filtrate was measured for its absorbance. Then repeated with variations in the concentration of crystal violet 0.15; 0.2; 0.3; and 0.35 ppm.

Results and discussion

Nanomagnetite

The synthesis of nanomagnetite is carried out by the method of coprecipitation. The reaction between Fe^{2+} solution and Fe^{3+} solution in an alkaline atmosphere with the addition of NaOH will form a Fe_3O_4precipitate. The reaction equation occurs as follows:

$$Fe^{2+} + 2OH^- \rightarrow Fe(OH)_2 \quad (1)$$

$$2Fe^{3+} + 6OH^- \rightarrow 2Fe(OH)_3 \quad (2)$$

$$Fe(OH)_2 + 2Fe(OH)_3 \rightarrow Fe_3O_4 + 4H_2O \quad (3)$$

The synthesis of nanomagnetite producing a solid black colored powder is shown in figure 1. The formed nanomagnetite will be attracted by the outer magnetic field, separation is carried out to find out which nanomagnetite was successfully synthesized. In addition to separation using an outer magnetic field, synthesized nanomagnetites are characterized using X-Ray Difraction

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(XRD), Scanning Electron Microscopy (SEM), and Fourier Transform Infrared Spectroscopy (FTIR) instruments.

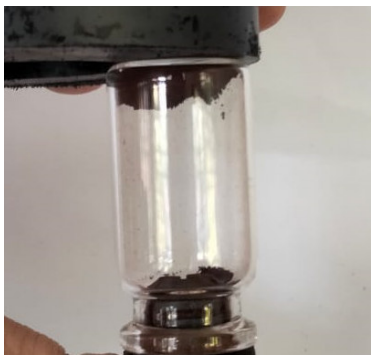


Figure 1. The result of the synthesis of nanomagnetites attracted by magnets.

Characterization of nanomagnetite using x-ray difraction (XRD) instruments

Analysis of nanomagnetite synthesis results using XRD instruments in the form of diffractograms is shown in figure 2. The emerging nanomagnetite diffractogram saw the highest peak at an angle of 2θ of 35.43°. In addition there appear several peaks of high intensity at an angle of 2θ of 42.95° and at an angle of 2θ of 57.53°. Other peaks will appear at a 2θ angle of 30.65° and 62.65° showing the characteristics of nanomagnetites.

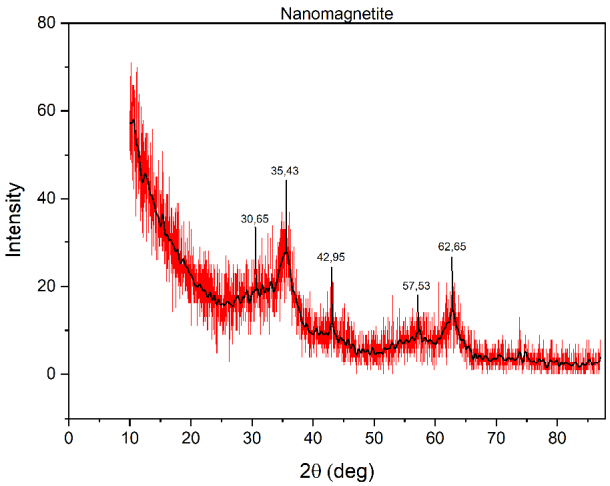


Figure 2. Difractogram XRD nanomagnetite.

According to JCPDS (*Joint Commite For Powder Diffraction Standart*) No 19-0629 Fe_3O_4 has an identical X-ray diffraction pattern at a 2θ angle i.e. at 30.1°, 35.4°, 37.1°, 43.1°, 53.4°, 56.9°, 62.5°, 70.9°, 73.9°. The peaks formed in the results of the nanomagnetite synthesis analysis showed that the resulting pattern corresponded to the standard range of JCPDS No 19-0629 and previously conducted studies [5].

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Nanomagnetite characterization using scanning electron microscopy (sem) instruments

The *Scanning Electron Microscopy* (SEM) instrument is used to determine the surface of the synthesis result as nanomagnetite. Nanomagnetite with its magnetic properties produces SEM images of small spherical spherical particles interacting with each other shown in figure 3. The interaction between the particles causes the image to look like a blob, which means that the particles are agglomerated or agglomerating. Agglomerations make the particle size look larger and can affect the magnetism properties of nanomagnetites. SEM results were analyzed using the ImageJ application to measure the diameter of nanomagnetite at 10,000x nanomagnetite magnification. Measurements showed the synthesized nanomagnetite had an average size of 35 nm. Nano particles have a diameter size of less than 100 nm, the results show that the resulting magnetite is nano-sized particles.

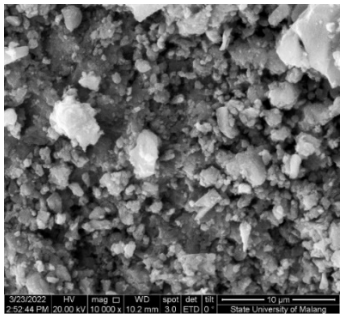


Figure 3. Morphology SEM Fe_3O_4 (10000x magnification)

Nanomagnetite characterization using fourier transform infrared spectroscopy (ftir) instruments

Another instrument used in the characterization of nanomagnetite is the *Fourier Transform Infrared Spectroscopy* (FTIR). The resulting peaks of the FTIR spectrum showed wavelength peaks of 565.14 cm^{-1} and 445.55 cm^{-1} showed Fe-O bonds in nanomagnetites, other peaks that appeared were 3419.79 cm^{-1} and 1631.78 cm^{-1} showing O-H bonds shown in figure 4. The O-H bond in nanomagnetite comes from water molecules found in the crystal lattice.

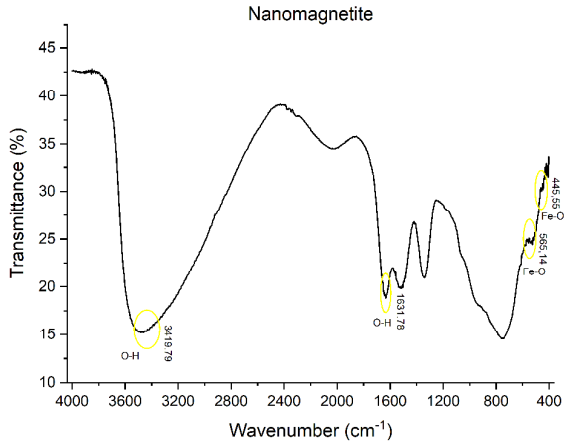


Figure 4. FTIR spectrum of Fe_3O_4

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The resulting peaks show compatibility with previous studies where there are typical Fe-O peaks in the wavelength range of 400-600 cm^{-1} [11].

Silica synthesis from beach sand

The beach sand used for silica synthesis is taken from Ungapan Beach, Malang Regency. Sand is taken close to the shoreline to reduce the risk of impurities on the beach sand. The sand of Ungapan Beach is soaked with HCl to remove existing impurities like other metals found in the sand. The sand is then refluxed in NaOH to dissolve the silica into sodium silicate ($NaSiO_3$).

Sodium hydroxide dissociates so that the hydroxide ion (OH^-) acts as a nucleophile attacking the electrophile, namely the Si atom and forming SiO_2OH^- as an intermediate. The subsequent release of H^+ ions will produce SiO_3^{2+} and H_2O. Sodium ions resulting from the dissociation of sodium hydroxide will bind to oxygen so that sodium silicate ($NaSiO_3$) is formed [16]. The formation of Sodium Silicate from beach sand added with NaOH has a mechanism as shown in Figure 5.

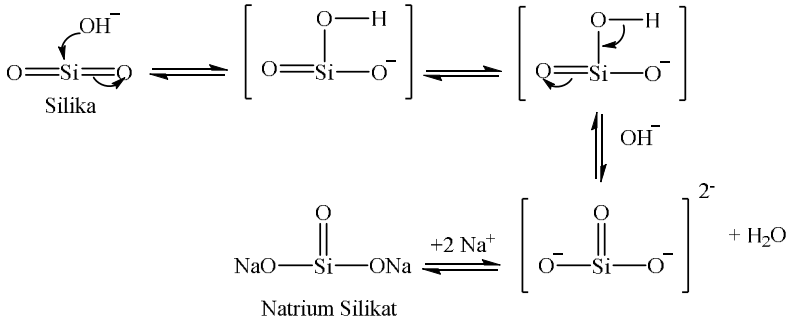


Figure 5. Reaction mechanism of sodium silicate

The resulting sodium silicate filtrate ($NaSiO_3$) group ($Si\text{-}O^-$) undergoes protonation by donating H^+ ions to form a silanol group (Si-OH). The continuous addition of acid causes the siloction group ($Si\text{-}O^-$) to form a bond with the syllanol group (Si-OH) so that a Si-O-Si bond or siloxan is formed [6]. The reaction mechanism of silica gel formation is shown in figure 6. To form the formed silica gel powder is filtered and washed using aqueous and then dried.

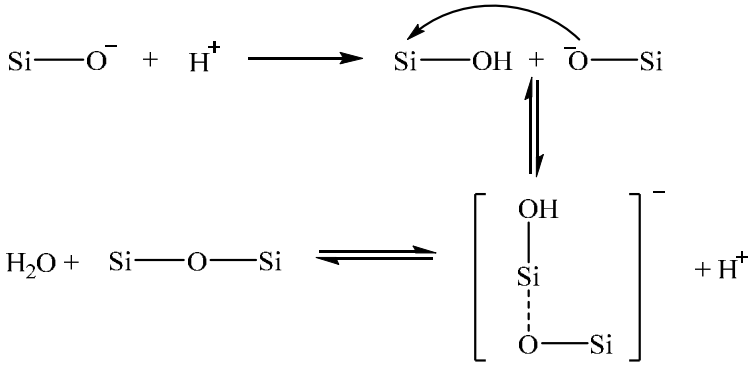


Figure 6. The mechanism of silica gel formation

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The synthesis of silica producing a white powder is shown in figure 7. The results of silica synthesis were analyzed using instruments including X-Ray *Fluorescence* (XRF), *X-Ray Difraction* (XRD), and *Fourier Transform Infrared Spectroscopy* (FTIR).



Figure 7. The result of silica synthesis.

Silica characterization using x-ray fluorescence (XRF) instruments

The material content of Ungapan beach sand was analyzed using the *X-Ray Fluorescence* (XRF) instrument. The material content produced in the synthesis process is shown in the following table:

Table 1. Material content of synthesis materials.

Oxide	Composition (%)
SiO_2	23,1
CaO	51,7
Fe_2O_3	16,1
Al_2O_3	3,7
TiO_2	1,95
SrO	1,4

In contrast to the synthetic material in the synthesis material, the Ungapan Beach sand has the material content shown in the following table:

Table 2. Material content after synthesis

Oxide	Composition (%)
SiO_2	97,2
CaO	0,56
Fe_2O_3	1,58

The material produced by silica synthesis produces a percent silica composition of 97.2%. In addition to silica, there are other materials that still remain quite a lot such as CaO and Fe_2O_3 but with less composition. The composition of CaO after the synthesis process of 0.56% indicates a decrease in the previous composition of 51.7%. As for Fe_2O_3 the composition after the synthesis process was 1.58% which was previously 16.1%. In addition, the content of other materials such as Al_2O_3 and SrO is completely lost in the synthesis process. This decrease suggests that leaching using hydrochloric acid dissolves other materials [7].

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Silica characterization using x-ray difraction (XRD) instruments

The XRD instrument according to the research that has been carried out the results of the silica diagram that appears will see a ramp peak with an intensity at an angle of 2 θ from 22.587° this peak corresponds to ICSD 98-016-2660 and identifies the formation of silica [7]. The results of the silica synthesis X-ray diffraction pattern showed peak dilation at 22.1°. The synthesis of silica from the sands of Ungapan beach produced the X-ray diffraction pattern shown in figure 8.

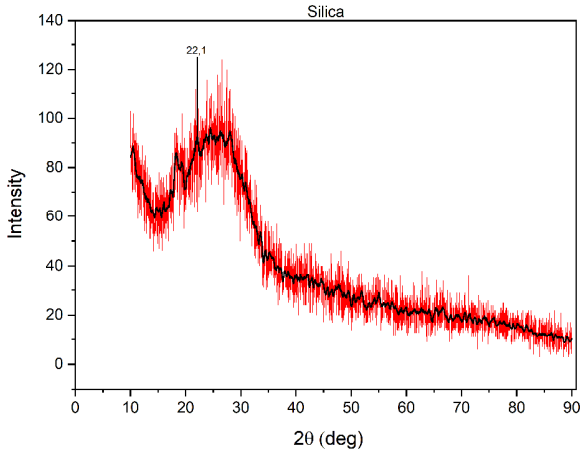


Figure 8. Diffractogram of silica using XRD

The resulting peak XRD analysis of synthesized nanomagnetite showed conformity with previous studies. The silica diffraction pattern is identical to peak dilation at a 2θ angle in the range of 21-23° [6].

Silica characterization using a fourier transform infrared spectroscopy (FTIR) instrument

The results of the FTIR instrument analysis in the research that has been carried out show the vibration of Si-O-Si at a wavelength of 1037.7 cm^{-1}, Si-OH at a wavelength of 894.97 cm^{-1}, and Si-O at a wavelength of 464.84 cm^{-1} which shows the formation of silica as shown in figure 9. The wavelength of 3417.86 cm^{-1} indicates the formation of a ullur vibration indicating the presence of an O-H group in the silanol group (Si-O-H) and reinforced by the presence of bending vibrations at a wavelength of 1633.71 cm^{-1}.

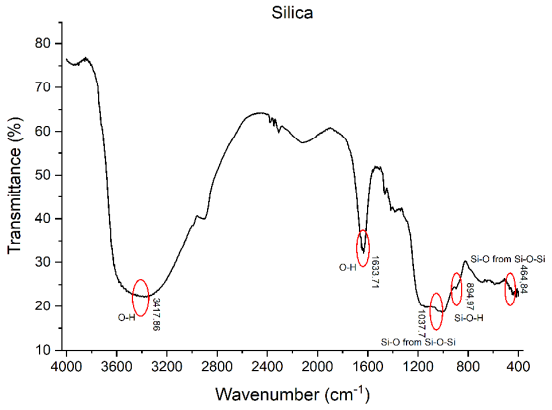


Figure 9. FTIR spectrum of silica

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The peak of the FTIR spectrum resulting from silica synthesis from the Ungapan beach sand shows that it is compatible with the silica synthesis research that has been carried out, there is a typical Si-O-H peak at a wavelength of 798.8 cm^{-1} and a Si-O peak at a wavelength of 475.1 cm^{-1} [7].

Silica coated nanomagnetite as a dye adsorbent

The synthesis of silica-coated nanomagnetite results from the mixing of silica gel synthesized from Ungapan beach sand and nanomagnetite synthesized by the coprecipitation method. Silica-coated nanomagnetite in the synthesis process will produce a brownish-black powder as shown in figure 10. Silica-coated nanomagnetite has magnetic forces that can be attracted by the outer magnetic field [18]. The synthesis results of silica-coated nanomagnetite were proven using X-Ray Difraction (XRD), Scanning Electron Microscopy (SEM), and Fourier Transform Infrared Spectroscopy (FTIR) instruments.

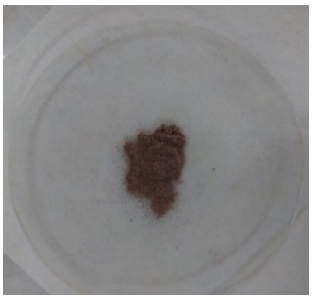


Figure 10. Silica coated nanomagnetite synthesis results

Characterization of silica-coated nanomagnetite using x-ray difraction (XRD) instruments

The instrument, namely XRD (X-Ray Difraction) will show the difference in the results of pure nanomagnetite, silica and silica-coated nanomagnetite. Research that has been carried out shows that there are differences in XRD results as shown in figure 11. The diffractogram produced in the analysis of silica-coated nanomagnetite showed the presence of a combination of typical patterns between silica and nanomagnetite. The typical silica pattern with peak dilation and the typical nanomagnetite pattern are some high-intensity peaks.

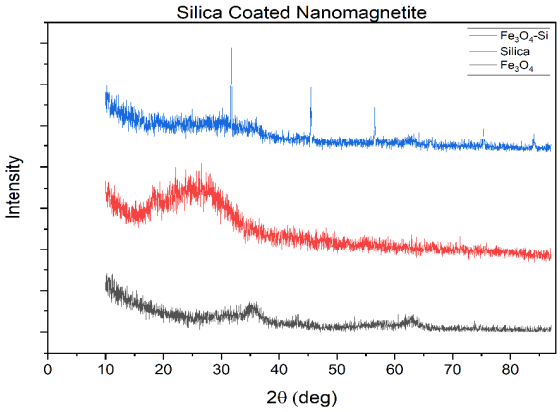


Figure 11. Diffractograms of Fe_3O_4-Silica, silica, and nanomagnetite

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Peak dilation at a 2 θ angle in the range of 21-23° in silica-coated nanomagnetite results identifying the presence of a distinctive silica pattern [6]. High-intensity peaks at a 2θ angle of 35° show a distinctive pattern of Fe_3O_4 in silica-coated nanomagnetite results. Another pattern that shows the typical pattern of Fe_3O_4 is at a 2 θ angle of 42° and 62° [5].

Silica coated nanomagnetite characterization using scanning electron microscopy (SEM) instruments

The Scanning Electron Microscopy (SEM) instrument of the synthesis of silica-coated nanomagnetite is shown in figure 12. SEM results were analyzed using the ImageJ application to measure the diameter of silica-coated nanomagnetite with a magnification of 50000x. The particle size of silica-coated nanomagnetite ranges from 73 nm or twice as large as that of nanomagnetite without coatings. This size comparison shows that silica-coated nanomagnetite has formed. Particles with a diameter size below 100 nm are called nanoparticles. The size of silica-coated nanomagnetite belongs to the nanoparticle size.

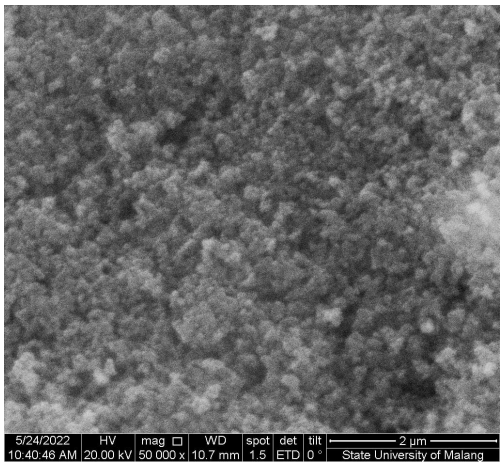


Figure 12. Morphology SEM Fe_3O_4- silica (50000x magnification)

Silica coated nanomagnetite characterization using a fourier transform infrared spectroscopy (FTIR) instrument

Another instrument that can prove the formation of silica-coated nanomagnetite is the Fourier Transform Infrared Spectroscopy (FTIR). The FTIR spectrum produced by pure nanomagnetite will be different from the spectrum of silica-coated nanomagnetite. The spectrum of silica-coated nanomagnetite exhibits Si-O-Si and Si-OH vibrations that distinguish it from the pure nanomagnetite spectrum. The spectrum of silica-coated nanomagnetite shows Si-OH vibration at a wavelength of 898.83 cm^{-1}. in addition, the vibration that signifies the typical silica pattern is the presence of Si-O-Si vibration at a wavelength of 1031.92 cm^{-1}. Meanwhile, the peak that shows the presence of nanomagnetite in the synthesis results of silica-coated nanomagnetite, namely at a wavelength of 416.62 cm^{-1} indicates the presence of Fe-O. The comparison of the spectrum of pure nanomagnetite and silica with the spectrum of silica-coated nanomagnetite is shown in figure 13.

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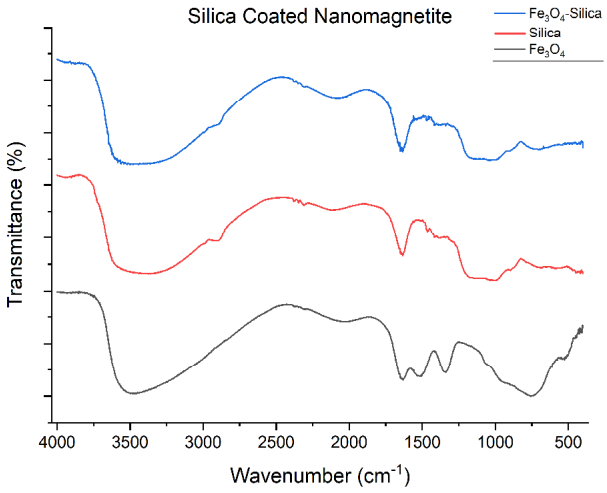


Figure 13. FTIR spectrum of (a) Fe_3O_4-Silica, (b) Silica and (c) Fe_3O_4.

The peak of the FTIR spectrum resulting from the synthesis of silica-coated nanomagnetite from Ungapan beach sand shows compatibility with the results of nanomagnetite synthesis without coatings and also silica. The FTIR spectrum resulting from the synthesis of silica-coated nanomagnetite has a pattern that shows nanomagnetite bonds and also silica bonds.

Adsorption of crystal violet dyes with silica coated nanomagnetite adsorbent

The determination of the percent adsorption and adsorption capacity of silica-coated nanomagnetite against crystal violets begins with the determination of the maximum wavelength and the creation of a calibration curve. The maximum wavelength of crystal violets is obtained by measuring the absorbance of crystal violet solutions with a concentration of 0.3 ppm in the wavelength range of 585-595 nm. The maximum wavelength of crystal violets is obtained at a wavelength of 590 nm as shown in figure 14.

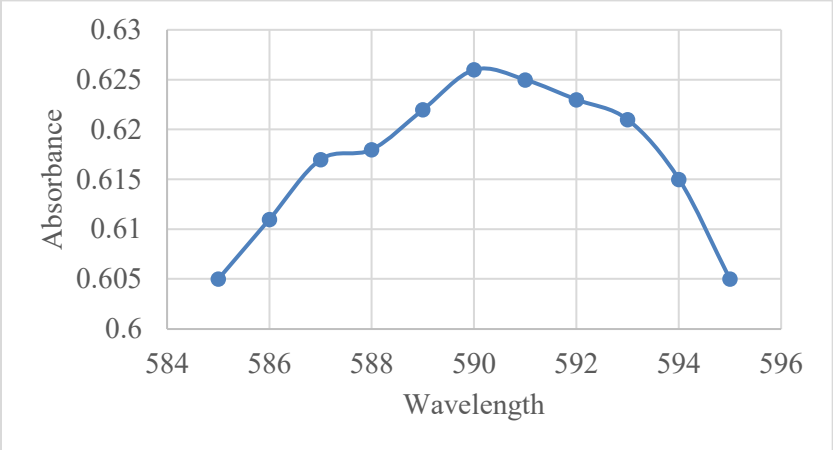


Figure 14. Graph of the maximum wavelength of crystal violets

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The calibration curve is used to determine the regression equation used in the calculation of concentrations on the adsorption of crystal violets. The creation of a calibration curve is carried out by measuring the absorbance of the crystal violet solution with various concentrations at the maximum wavelength. Absorbance measurements were carried out at a concentration of 0.10; 0,15; 0,20; 0,25; 0,30; 0,35; and 0.40 ppm.

The application of silica-coated nanomagnetite is used in the adsorption of crystal violets to prove that silica-coated nanomagnetite can be used as an adsorbent against crystal violets. The application of silica-coated nanomagnetite adsorbents for crystal violet dyestuffs is carried out by varying the adsorbent mass in the crystal violet solution. The decrease in the concentration of the crystal violet solution can be seen from the filtrate obtained by the *Visible Genesys* 20 spectrophotometer test.

The dye is absorbed at a concentration of 0.25 ppm with an adsorbent mass of 0.5 grams of 92%. An adsorbent mass adsorption percentage of 0.7 grams showed crystal violets absorbed close to 100% using a *Visible Genesys* 20 spectrophotometer. The increase in adsorption percent indicates that adsorbents still have adsorption ability due to the lack of binding sites that bind to crystal violet compounds so that the compounds are not fully absorbed. The percentage of adsorption at an adsorbent mass of 0.8 grams is equal to the result of adsorption at a mass of 0.7 grams. The mass of the adsorbent is above 0.7 grams or the optimum mass of the binding site that binds to the crystal violetline compound more so that the crystal violetline compound is absorbed more [1]. The measurement results show that the crystal violet content in the adsorbate is below the measurement threshold using the *Visible Genesys 20* spectrophotometer so that the results show that the adsorp crystal violet dye is close to 100%.

Based on the adsorption percent data, the adsorption capacity of silica-coated nanomagnetite was calculated against 25 mL of crystal violet solution with a concentration of 0.25 ppm. Percent adsorption of crystal violets is close to 100% at an adsorbent mass of 0.7 grams. The adsorption capacity is calculated at the maximum state of the crystal violetline dye absorbed by the adsorbent. The adsorption capacity of silica-coated nanomagnetite of 0.0089 mg/g indicates that as much as 0.0089 mg of crystal violetline dye is absorbed by 1 gram of silica-coated nanomagnetite adsorbent.

Silica-coated nanomagnetite was developed to develop efficient and repeatable pewara adsorbents. Repeated adsorbent tests were carried out with the same concentration of crystal violet solution at 0.25 ppm. The results of adsorption of repeated adsorbent use can be seen in figure 15.

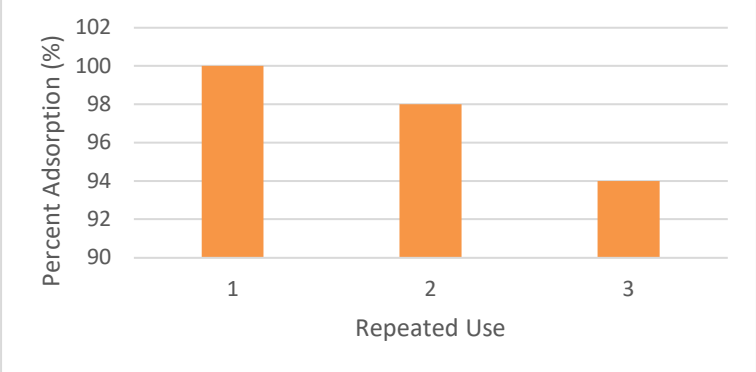


Figure 15. Test results of repeated adsorbent used

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Based on the results of repeated use, silica-coated nanomagnetite adsorbents have low adsorption working power when used in the second and third applications. Percent of adsorption in the second use decreased by 2% and in the third use decreased by 6% from the initial close to 100%. This decrease is due to the silica contained on the surface of the nanomagnetite being released so that there is a lack of adsorbent binding to the crystal violet compound. Silica on the surface of detached nanomagnetite is characterized by a decrease in the adsorbent mass of 0.7 g to 0.552 g in the second use and in the third use to 0.5 g. In addition to the reduction of the adsorbent mass the detachment of silica is characterized by turbidity at the time after application of the solution looks cloudy. The release of silica from the surface of the nanomagnetite in the application of adsorbents indicates that repeated use cannot be carried out.

Repeated use of adsorbents depends on the interaction that occurs between adsorbents and adsorbents. Adsorbents cannot be reused and require washing if the interaction occurs is a chemical interaction. The interaction that occurs in the adsorbent during the adsorption process can be known through the determination of the isotherm curve. Langmuir's isotherm curve is shown in figure 16 and Freundlich's isotherm curve is shown in figure 17.

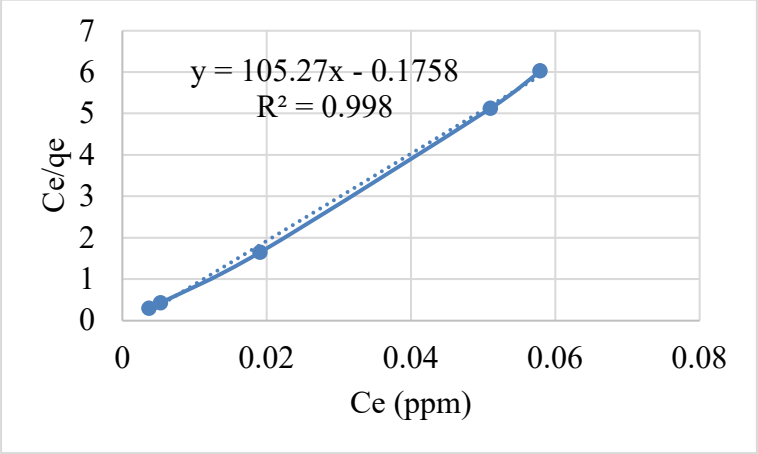


Figure 16. Langmuir isotherm curve

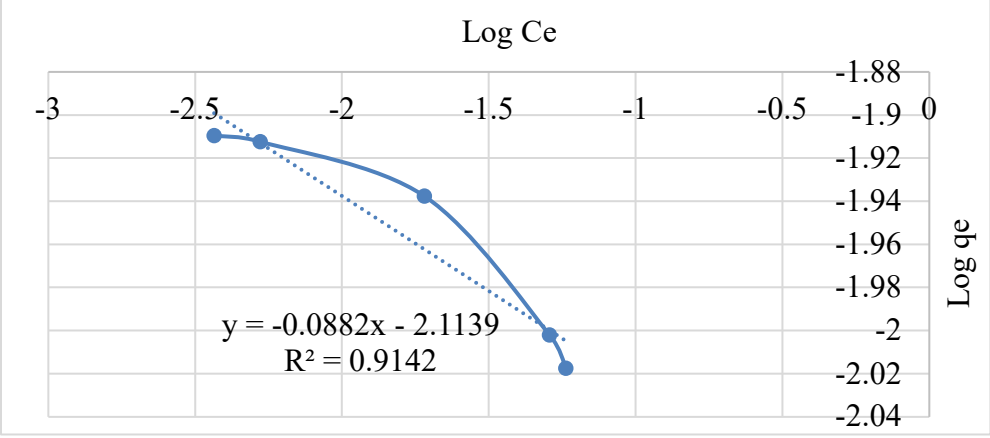


Figure 17. Freundlich isotherm curve

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Based on the Langmuir isotherm curve in figure 16 and the Freundlich isotherm curve in figure 17 shows adsorption using silica-coated nanomagnetite adsorbents following the Langmuir isotherm model. Langmuir isotherm indicates that there is a chemical interaction between adsorbent and adsorbate. Silica-coated nanomagnetite adsorbed the crystal violet dye at the active center found on the adsorbent surface. The adsorption process will produce a single-layer adsorbate layer [9]. Previous research also explained that the adsorption process using silica for dyestuffs follows the Langmuir isotherm model which indicates that adsorption using silica is a chemical adsorption [10]. This reinforces that the use of silica-coated nanomagnetite adsorbents is a chemical adsorption that cannot be used repeatedly without going through the process of unbinding adsorbate with adsorbents.

The use of nanomagnetite without coatings and silica has several disadvantages when used as an adsorbent. Nanomagnetite has disadvantages such as being easily oxidized and has an agglomerated structure so that coatings are needed. Silica and magnetite that are nano-particle in size have the disadvantage that they are easily dispersed in water so that they are difficult to separate. The combination of nanomagnetite with silica coatings provides the advantage of reducing the possibility of nanomagnetite oxidation and facilitating the separation of adsorbents from the matrix [11]. The merger of nanomagnetite and silica occurs due to the presence of Fe-O bonds in nanomagnetite that bind to silica through a siloxane group (Si-O-Si). Silica has a silanol group (Si-OH) which plays a role in the adsorption process. The mechanism of binding of crystal violetline compounds with the active group Si-OH or silanol on the adsorbent surface is shown in figure 18.

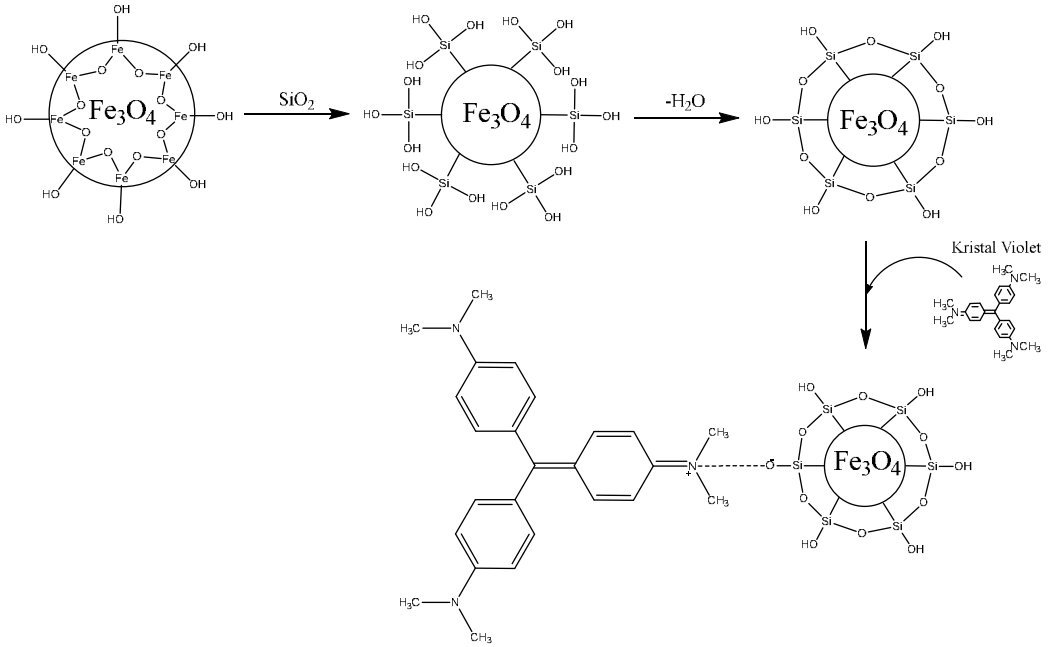


Figure 18. The mechanism of bonding crystal violets against silica-coated nanomagnetite

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Conclusion

Silica-coated nanomagnetite adsorbents have been successfully synthesized. The silica-coated nanomagnetite XRD diffractogram shows a peak with high intensity at an angle of 2θ from 35° and a dilation of the peak at a 2θ angle of 21-23°. The morphology of the material using Scanning Electron Microscopy (SEM) shows that the size of the surface diameter of silica-coated nanomagnetite averages 73 nm. The material producing the Fourier Transform Infrared Spectroscopy (FTIR) spectrum shows the Si-O-Si bond in the presence of ulur vibration at a wavelength of 1031.92 cm^{-1} and shows the Fe-O bond at a wavelength of 416.62 cm^{-1}. In repeated use the reduced adsorbent mass indicates that the adsorbent cannot be used repeatedly supported by silica-coated nanomagnetite adsorbent isotherm curve data following the Langmuir model. The Langmuir isotherm model indicates a chemical interaction between adsorbent and adsorbate. So that the adsorbent cannot be used repeatedly without breaking the adsorbent bond with the adsorbent.

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Eliminating misconception on solubility and Solubility Product Constant (K_{sp}) using ECIRR learning model

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Abstract. *A significant problem in chemistry teaching nowadays is misconception. Several studies detail common misconceptions among students regarding solubility and solubility product constant. This study aims to eliminate the solubility (s) and solubility product constant (Ksp) misconceptions using the ECIRR learning model. Two homogeneous classes were used in this pretest-posttest control group design. The ECIRR learning model was used in one clas, and discovery learning was used in the other. Using a three-tier test, the misconceptions that students had in s and Ksp were identified. The percentage of s and Ksp misconception elimination using ECIRR from 25 to 3.9. Elimination of misconception in s and Ksp using ECIRR showed a significant with Wilcoxon Segned Rank Test. Since this lerning model effectively eliminate misconception, the use of ECIRR in the instruction of other chemistry materials with similar characteristics is strongly recommended.*

Keywords: Misconception, ECIRR, Solubility (s), Solubility product constant (Ksp)

Introduction

According to a survey in the United States, solubility equilibrium is one of the chemical materials considered difficult by chemistry students and teachers [1]. This fact is supported by research that reports students' difficulties and misconceptions in almost all concepts of solubility equilibrium [2-4]. In understanding the solubility equilibrium material, several prerequisite concepts must be understood first, such as solubility, chemical and physical equilibrium, Le Chatelier's law, solution

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chemistry, and chemical equations [2]. In addition, solubility equilibrium materials have an abstract basis, complex mathematical calculations, and very complex concepts [2-6].

Misconceptions are still a big problem in chemistry learning because they can negatively impact subsequent learning of related concepts [7-8]. In chemistry, concepts are interrelated [9]. Thus, failure to understand basic or prerequisite concepts tends to make it difficult to understand the next topic [10-11]. The study of chemistry requires a thorough understanding of the prerequisite topics [12-13]. Students will struggle to learn new concepts if they can't relate necessary concepts to other new concepts [14-15]. If this continues to happen to students, they have the potential to experience misconceptions, namely understanding concepts that are not those developed by experts [16]. This emphasizes eliminating students' misconceptions about the prerequisite material before learning a new concept.

Discovered a misconception on the relationship between solubility and the value of K_{sp}. Based on the specified value of Ksp, the researcher provides a question about the salts that are most soluble with various amounts of ions. 85.37% of students fell into the misconception category. There are a lot of students that have encountered misconceptions. The majority of students believe that salts' high solubilities translate into high Ksp values regardless of the salt's ion content. The right idea is that the solubility increases with increasing Ksp values in salts with the same amount of ions. The solubility of each salt must be determined in advance, though, if the salt has a varied amount of ions. In Addition, 71.95% of students who had misconceptions thought saturated solution happened when the product concentration was lower than Ksp. The right idea is that a saturated solution occurs when the product ion concentration exceeds Ksp. On the other hand, an unsaturated solution develops when the product concentration is lower than Ksp [4].

To eliminate misconceptions, a variety of techniques are employed. A conceptual change strategy is one of them. This strategy has been used to eliminate misconceptions about chemical reaction equations [17], material properties, atomic structure, chemical reactions, and stoichiometry [18], chemical bonds [19], and Acid-Base [20]. However, the elimination carried out in regular learning is less than optimal regarding time efficiency and student participation [21]. As a result, an innovative learning model is needed to eliminate misconceptions optimally and produce a proper understanding of related new concepts. One of the learning models for overcoming misconceptions is the ECIRR (Elicit-Confront-Identify-Resolve-Reinforce) model [22].

The ECIRR learning model is carried out through 5 stages. The first stage is Elicit, at this stage, the teacher investigates students' misconceptions through questions, dialogues, or asking students to explain a process or phenomenon. Furthermore, at the Confront stage, the teacher shows a certain phenomenon to create a contradiction to the student's statement, then provides an opportunity for students to compare the concepts that have become students' misconceptions with the observed phenomena. The discrepancy between the phenomena seen and previously understood concepts causes cognitive conflicts in students' minds, so students experience cognitive imbalance (disequilibrium). Identify stage, is a very important step. Alternative conceptions can mislead students' understanding so there is an identify stage. The teacher must make students aware of alternative conceptions in themselves.

Furthermore, at the resolve stage, the teacher provides the correct concepts by showing evidence that can be extracted from the observed phenomena. Students construct new concepts that are different from previously understood concepts. The last stage is reinforce also very important. As explained earlier, alternative conceptions are difficult to remove, so learning is not done to remove

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alternative conceptions but to create conditions where new knowledge becomes more easily called upon than students' alternative conceptions. At this stage the teacher must provide reinforcement repeatedly and in various ways. Another way is to ask conceptual questions [23].

The ECIRR Learning Model has been widely applied in eliminating the misconceptions of redox reaction materials [24], chemical equilibrium [25], work and simple machines [26], Chemical bonding [27]. The results of these studies indicate that learning using the ECIRR learning model effectively facilitates conceptual change and eliminates misconceptions in students. Based on the existing problems by knowing the success of the application of the learning model to see the disappearance of students' misconceptions in studying the Solubility and Solubility Product by applying the ECIRR Learning Model.

Methodology

Research design

The sample in this study consisted of 43 students majoring in science from two classes at SMA Negeri 2 Gorontalo, Indonesia. The experimental class consisted of 20 students who were taught using the ECIRR learning model. The control class consisted of 23 students who were taught using the *discovery learning* model. The three-tier diagnostic test adopted by [28] was given to both classes before learning.

The pretest-posttest control group design was used to test the effectiveness of the learning model to eliminate the misconceptions of S and Ksp students by comparing the elimination presentations experienced by students in the experimental class and the control class following the Hake category [29]. The design of research design is given in Table 1. The three criteria for eliminating misconceptions developed by Hake are given in Table 2.

Table 1. Research design pretest-posttest control group design (adapted from Creswell, 2012)

Subject	Pre-test	Treatment	Post-test
Experiment Class	O_1	X_1	O_2
Control Class	O_3		Oh $_4$

X_1 = Treatment (learning with *ECIRR* Model), O_1 and O_3 = Early conception understanding test (*pre-test*), O_2 and O_4 = Final conception understanding test (*post-test*)

Table 2. Criteria for elimination of misconceptions

Percentage of misconceptions eliminated (%)	Criteria
71 – 100	Height
41 – 70	Currently
0 – 40	Low

Research instrument

Three-tier diagnostic test (TDT)

Three-tier diagnostic test consisted of 6 indicators spread over 14 questions. The first level (tier 1) consists of 2-5 choices of answers to questions or statements that have been given. The second level (*tier* 2) consists of 4 reasons and 3 possible reasons for the answers chosen by students on the first level questions (tier 1) or write down the appropriate reasons for the fifth item if there is no appropriate choice. The third level (*tier* 3) is in the form of a student's belief statement, which is sure or not which can measure the level of student confidence or belief in the answer. *Three-tier*

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diagnostic test has an average content validity of 90.7% which is included in the very high category. The reliability coefficient of this test, calculated by the Cronbach Alpha formula, is 0.79, including the high category.

Students who experience misconceptions about solubility and solubility products are determined based on the criteria developed by [28] are given in Table 3. *Three-tier diagnostic tests* are given to both classes before and after the implementation of learning.

Table 3 . Criteria for students' misconceptions with the instrument *three-tier diagnostic test*

No	Tier 1	Tier 2	Tier 3	Criteria
1	Right	Right	Sure	Know the Concepts (TK)
2	Right	Wrong	Sure	Misconception 1 (MK 1)
3	Wrong	Right	Sure	Misconception 2 (MK 2)
4	Wrong	Wrong	Sure	Misconception 3 (MK 3)
5	Right	Right	Not sure	Don't Know the Concept (TTK)
6	Right	Wrong	Not sure	Don't Know the Concept (TTK)
7	Wrong	Right	Not sure	Don't Know the Concept (TTK)
8	Wrong	Wrong	Not sure	Don't Know the Concept (TTK)

Data analysis

The data in this study are quantitative data. Quantitative data were obtained from giving the test twice, namely before treatment (*pretest*) and after treatment (*posttest*) in the experimental and control classes.

The percentage of misconceptions that occur in students are analyzed using:

$$P = \frac{\mathrm{F}}{\mathrm{N}} \times 100\% \quad (1)$$

With:
P = the percentage of students who experience misconception.
F = students who experience misconception.
N = the number of participants.

The results of the misconception calculation are categorized based on Table 4.

Table 4. Level of misconception criteria

P Value	Category
61%-100%	High
31%-60%	Medium
0%-30%	Low

In implementing the ECIRR learning model in the classroom, observations were done using an observation sheet. Observation results were analyzed using formulas:

$$\text{Percentage} = \frac{Total\ Score}{Maximum\ number\ of\ questions} \times 100\% \quad (2)$$

The results obtained are categorized according to Table 5.

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Table 5. Learning implementation criteria

Value	Category
0%-20%	Very Not Good
21%-40%	Not Good
41%-60%	Good Enough
61%-80%	Good
81%-100%	Very Good

The percentage of elimination used to convey the data on misconceptions is computed using the formula below.

$$\%E = \frac{x}{n} \times 100\% \quad (3)$$

$\%\ E$ = Percentage of elimination of misconceptions

X = the difference in the number of students who experienced misconceptions before and after treatment.

n = the number of students who experienced misconceptions before being given treatment.

The average percentage of misconceptions was calculated using the following formula.

$$\%\overline{E} = \frac{\sum(E \times \%E)}{\sum E} \quad (4)$$

E = Number of misconceptions removed (difference of misconceptions before and after learning).

$\%\ E$ = Percentage of elimination for each misconception

E = total number of misconceptions eliminated

$\%\sum\bar{E}$ = mean percentage of misconceptions elimination

The effectiveness of the ECIRR learning model in eliminating misconceptions is based on the presentation of the elimination of misconceptions and the criteria developed by Hake.

Result and discussion

Misconceptions on solubility and solubility products constant

Based on the identification and analysis of the results of diagnostic tests (pre-tests) on students, it was found that students experienced misconceptions on all indicators on the solubility and solubility product constant, as shown in Table 6.

Based on table 6, it is known that the highest number of misconceptions occurs in the indicator explaining the concept of solubility product constant, which is 35% of students, and the lowest in explaining the concept of solubility, which is 15% of students. The average value of student misconceptions, 25%, is classified as low. In addition, diagnostic tests (pre-tests) results also showed that 47.9% of students did not know the concepts of the solubility and solubility product constant.

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Table 6. Misconceptions on solubility and solubility products constant

No	Indicator	Questions	Misconceptions
1.	Explaining the concept of insoluble salt equilibrium	1	20%
2.	Distinguishing unsaturated, saturated, and passing saturated solutions	2	20%
3.	Explaining the concept of solubility	3	30%
		4	25%
		5	25%
		6	15%
		7	30%
4.	Explaining the concept of solubility product	8	35%
5.	Explaining the Concept of Settling	9	25%
		10	25%
6.	Explaining the concept of the influence of namesake ions on solubility	11	20%
		12	25%
		13	25%
		14	30%

There are several reasons for misconceptions. Gabel mentioned that students experience misconceptions because of the characteristics of complex chemical concepts and the way chemistry concepts are learned in class. In general, misconceptions are caused by several things, including: i) knowledge for the explanation of concepts regarding the latest development of chemistry is not enough, ii) explanations of concepts to be simpler are still lacking or even excessive, iii) mastery of chemical concepts that are still lacking, and iv) sometimes explanations of concepts are not appropriate because they use language areas that are not representative. In addition, teachers and books can be a source of misconceptions within the school. At the same time, students' initial knowledge (preconceptions) gained through experience in everyday life can be a source of misconceptions outside of school [30-31].

The implementation of the ECIRR learning model

The results of the implementation of the ECIRR learning model are shown in Figure 1.

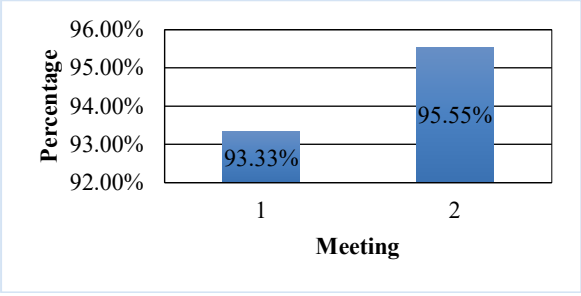


Figure 1. Percentage of implementation of the ECIRR model

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Based on Figure 1, the percentage of implementation of the ECIRR learning model is in very good category. That means applying the ECIRR learning model is well implemented to reduce students' misconceptions effectively.

The effectiveness of the ECIRR learning model to eliminate misconceptions on solubility and solubility products constant

Based on the calculation of the elimination percentage, it shows an elimination in the misconception of 78.3% for the experimental class and 37.8 % for the control class.

Eliminating of misconceptions is rated well in the experimental class whereas it is rated poorly in the control class. These findings show that the ECIRR learning model is more successful than discovery learning at eliminating misconceptions about solubility and solubility product, as seen in Table 7.

Table 7. Results of the effectiveness of the ecirr model

Subject	Number of students	Number of students in the category of elimination of misconceptions			Elimination average (%)
		Height	Medium	Low	
Experiment Class	20	10	6	4	74.5
Control Class	23	5	6	12	46,75

The average percentage of misconceptions eliminated in the experimental class, which is much greater than that in the control class., indicates that the ECIRR learning model has been successful in eliminating misconceptions among students. The elimination of misconception is rated highly for the experimental class and poorly for the control class according to the Hake category. The findings indicate that ECIRR is better than Discovery learning in terms of eliminating misconceptions. ECIRR uses cognitive conflict methods to resolve misconceptions, whereas direct explanation is used in discovery learning.

Students in the ECIRR class must resolve cognitive conflicts resulting from their misconceptions throughout this phase. Students' assumptions are contradicted by conflicts introduced by experimental data presentation media like animated movies [32]. Questions are provided along with the data. also encourages the development of students' scientific thinking skills in addition to creating a condition of dis-equilibrium. Students will therefore become aware that there is an issue with their comprehension, which puts them in an unbalanced state. This scenario won't endure long because self-control will restore its balance [33] and the development of students' reasoning abilities [34-35].

The students' cognitive abilities are another component that will help, since it can make it easier for them to comprehend the idea. If students frequently hear comments that will aid in the process of understanding concepts and eliminating misconceptions, Zimmerman argues, they can develop intellectually [36].

All forms of misconceptions must have their own unique cognitive conflict. Students are forced to reconstruct their misconceptions by cognitive conflict. This method calls for a lot of work, especially when it comes to producing anomalies that cause students to feel unsatisfied with their

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erroneous knowledge [37]. If the misconceptions are not removed immediately, it will interfere with learning in related concepts [7,12].

Conclusion

ECIRR is more effective in eliminating students' misconceptions in the solubility and solubility product constant than discovery learning . Elimination of misconceptions in the experimental class is in the high category while the control class is in the low category.

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Preservice chemistry students' responses to small scale chemistry workshop

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Abstract. *This study aims to reveal preservice chemistry students' responses to a small scale chemistry workshop recently organized in Indonesia. The survey sample comprised of 27 respondents of preservice chemistry students of the Department of Chemistry Education. Its respondents from 100 workshop participants, high school chemistry teachers in North Sumatra. The workshop was carried out for 2 days, 19th and 20th September 2022, which was held at the Chemistry Department, FMIPA UNIMED. Involving the instructor from Thailand's Chulalongkorn University assisted by 6 facilitators from the Chemical Society of Thailand and 6 trainers selected from previous-years workshop participants in Indonesia. Data were collected using a survey questionnaire of 18 statements using the Likert scale. Preservice chemistry students' responses were measured 5 aspects namely Interest and self-motivation (1); Knowledge (2); Skills (3); Effectiveness of time, chemicals and practical tools (4); Self-confidence (5). The results showed an average response score of 82, with the highest score of 90 and the lowest of 72. All responses were in the "positive" category (greater than 54). From the 5 aspects measured, the average score obtained for the first aspect was 28.15 (max. 30), the second and the third aspect were similar at 9.37 (max. 10), the fourth aspect was 22 .81 (max. 25), and the fifth aspect was 13.19 (max .15). All aspects show a positive category.*

Keywords: Small scale chemistry, chemistry, laboratory, practicum, response

Introduction

Chemistry is one of science that studies the structure of matter, composition of matter, properties and changes in matter in natural processes and in planned experiments [9]. To understand

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chemistry requires science process skills. Science process skills are rational thinking skills related to scientific activities, namely observing, predicting, concluding, classifying, measuring, and communicating. Science process skills are important because it can actively involve preservice chemistry students in learning, develop a sense of responsibility, increase independence, and require preservice chemistry students to analyze. Furthermore, studying chemistry requires the ability to master scientific facts, concepts, and theories so that preservice chemistry students can develop scientific concepts [10].

To improve preservice chemistry students' ability to learn chemistry, a learning process that actively involves students is needed. That can be done with practical activities because it can improve conceptual understanding, analytical skills, mastery of laboratories, and increase learning motivation [5]. Practical activities provide direct experience to preservice chemistry students so that they have a positive impact on critical thinking skills, communication skills, and collaboration [3]. Practical activities always about chemical substances and standard-sized practical tools. The use of chemical substances in large quantities leads to the disposal of excess reagents, solvents and the production of large amounts of chemical waste [5]. So far, chemical waste has not been handled properly, causing environmental pollution and having an impact on health [8]. The use of standard-sized practicum tools requires preservice chemistry students to carry out practical in the laboratory, this is to maintain the function and safety of the tool. Practical which always has to be done in the laboratory causes preservice chemistry students have difficulty learning independently because they feel unsafe doing practical outside the laboratory.

Small scale chemistry is a practical that is carried out by minimizing activities in general laboratory. Small scale chemistry is more environmentally friendly, reduces waste problems, saves costs and the time required is more efficient, safer so that it can be used both inside the laboratory and outside the laboratory. This is because Small scale chemistry uses a small scale so that less chemicals used, the practical tools are simpler by converting glass materials into plastic materials. Tantayanon, the Director of the DOW Chemistry Classroom Project of the Chemical Society of Thailand promotes the chemical safety and security of practical in standard classroom environment, either with natural ventilation or in the air-conditioned room, through the use of small amounts of chemicals and appropriate safety principles. Using less chemicals also reduces material costs and the time needed to carry out practical. Therefore, Small scale chemistry can be applied in the direct learning process to increase preservice chemistry students' involvement and interest in science, especially chemistry [1].

This paper reports the results of a survey of 27 preservice chemistry students' responses to the small scale chemistry workshop, who where the participants of a total of 100 in the workshop.

Methodology

The survey was conducted on 27 preservice chemistry students from the Department of Chemistry Education, FMIPA UNIMED participated in the small scale chemistry workshop on 19th and 20th September 2022 at the Department of Chemistry, FMIPA UNIMED. The instructor was Prof. Dr. Supawan Tantayanon from Department of Chemistry, Faculty of Science, Chulalongkorn University, Thailand, assisted by 6 team members from the Chemical Society of Thailand and Indonesia.

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Data was collected online by distributing a Linkert scale questionnaire via google form. The questionnaire consists of 18 statements covering 5 aspects, namely: (1) interest and self-motivation; 6 statements, (2) knowledge; 2 statements, (3) skills; 2 statements, (4) effectiveness of time, chemicals, and practical tools; 5 statements, and (5) self-confidence; 3 statements. The questionnaire was adapted from Fialli [1]. Statements in the questionnaire are answered according to a Likert scale and scored according to Table 1.

Table 1. Answer category

Choice	Score
Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly Agree	5

The data collected is then analyzed by calculating the number of respondents' average scores for each aspect according to the score of each statement in that aspect. Then, each aspect is categorized into categories. Categories for each aspect are determined by calculating the maximum score and minimum score, then determining the middle value.

For example, for the total of 18 statements:

$$\begin{aligned} \textit{Maximum score} &= \textit{5 x total of statements} \\ &= \textit{5 x 18} \\ &= \textit{90} \end{aligned} \quad (1)$$

$$\begin{aligned} \textit{Minimum score} &= \textit{1 x total of statements} \\ &= \textit{1 x 18} \\ &= \textit{18} \end{aligned} \quad (2)$$

In the interval 18 to 90, the mean score is 54. For the average response score 54, the response of ≤ 54 will be categorized as "negative" and for the average score of > 54, the response category will be "positive". In the same manner, for each aspect, the "negative" and "positive" response category can be calculated and the results are shown in Table 2.

Table 2. Category responses for each Aspect

Aspects	Number of Statement	"Negative" response category	"Positive" response category
(1) Interest and self-motivation	6	≤ 18	> 18
(2) Knowledge	2	≤ 6	> 6
(3) Skills	2	≤ 6	> 6
(4) Effectiveness of time, chemicals and practical tools	5	≤ 15	> 15
(5) Self-confidence	3	≤ 9	>10

Result and discussion

After participating in the small scale chemistry workshop, 27 preservice chemistry students were asked to fill out a questionnaire to determine their opinions according to the 5 aspects, namely

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(1) interest and self –motivation, (2) knowledge, (3) skills, (4) effectiveness of time, chemicals and practical tools, and (5) self-confidence. The following Figure 1 shows that the average score response for each aspect are within the positive response category.

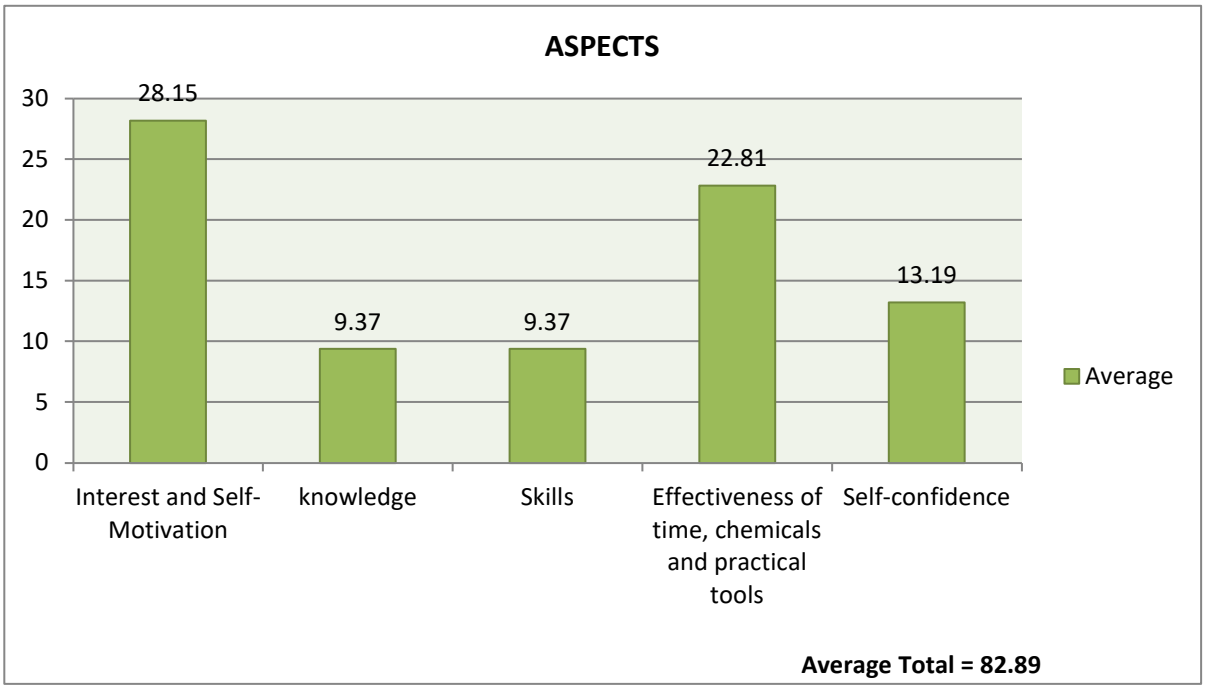


Figure 1. Distribution of the average score of aspects

The average score for the preservice chemistry students' responses to small scale chemistry workshop activities is 82.89, which is far from the minimum score for the positive response category of 54. This shows that preservice chemistry students agree that small scale chemistry activities provide many benefits, which were discussed separately in each aspect as follows.

Interest and self-motivation aspect:

In the aspect of interest and self-motivation, there are 6 statements with a maximum score of 30 and the average score obtained from the survey is 28.15, indicating the the positive category (score > 18) for the aspect.

Preservice chemistry students give a positive response to the aspect of interest and self-motivation from experiencing small scale chemistry technique. This is because it is easier for preservice chemistry students to do practical work both inside the laboratory and outside the laboratory [1]. This is also because small scale chemistry is designed to enclose the whole experiment in a plastic box that can contain adequate amounts of reusable plastic-based practical tools and necessary chemicals.

Small scale chemistry designed in this setup can help preservice chemistry students to learn independently. The use of small scale chemistry in South Africa received a very good response, students felt happy and excited when they did practical in the classroom [11]. Small scale chemistry can increase interest and motivation in learning science, especially chemistry because

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it can package practical activities to be more creative and innovative so that it looks more interesting [12].

Table 3. Interest and self-motivation aspect

ASPECT	STATEMENTS
Interest and self-motivation	Increase my interest in studying chemistry
	It will be useful/supportive in carrying out the task of teaching chemistry at school
	Increase my interest and motivation to carry out practical at school when I am a teacher
	Increase my interest in doing practical on a small scale
	Increase my interest in doing practical inside the laboratory and outside the laboratory
	Increase my interest in making chemistry/chemistry education a career



Figure 2. Small scale chemistry experiment box

Knowledge aspect:

In the aspect of knowledge, there are 2 statements with a maximum score of 10 and the average score obtained from the survey is 9.37 (positive category > 6). This shows that small scale chemistry has a positive impact on preservice chemistry students' knowledge.

Table 4. Knowledge aspect

ASPECT	STATEMENTS
Knowledge	Improve my understanding because the experiments carried out can prove the theories that I have learned
	Increase my insight because I can do small-scale practicum

Small scale chemistry through innovative approaches and effective teaching can make preservice chemistry students interested in the world of science. Tantayanon, the principal instructor of this Workshop, explained that the experimental box-set provided in the Workshop (see Figure 2) has been prepared for the nine experiments, namely, interdiffusion of gases,

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electrochemical separation of copper, solubility of ammonia, pH indicators, titration of strong acid with strong base, electrolysis of water, reaction of acid and carbonates, property of oxygen gas, and the law of conservation of mass [3]. However, it is not limited to these nine experiments. The participants can do many other experiments using this experimental box-set as well.







(a) (b) (c)

Figure 3. a) training on thesmall scale chemistry experiments, (b) pH indicator practical, (c) electrolysis of water practical

Small scale chemistry provides new insights to preservice chemistry students regarding the use of practical tools experiments to demonstrate the basic concept and the core knowledge of chemistry in a learning-by-doing concept. Research conducted by Urbano, regarding measuring students' learning and attitude as exposed to microscale laboratory experiments shows that the use of small scale chemistry in the learning process can help students understand the subject matter well because they can easily relate theoretical concepts to the actual observation during the practical work carried out [12].

Skills aspect:

In the skills aspect, there are 2 statements with a maximum score of 10 and the average score obtained from the survey is 9.37 (positive category, score > 6). This illustrates that the skill aspect gets a positive response.

Table 5. Skills aspect

ASPECT	STATEMENTS
Skills	Improve my ability to do various practicals on a small scale
	Improve my ability to use practical tools on a small scale

Small scale chemistry can give students the potential to significantly improve learning and development of conceptual understanding, laboratory process skills, communication and collaboration skills [6]. Tantayanon as an instructor in this small scale chemistry workshop said that although the chemicals and practical tools used were on a small scale, the accuracy of the tools was maintained as long as the chemicals used were not contaminated. So it would increase

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preservice chemistry students' ability to use or operate practical tools the same way as in the tranditional laboratory [1].

Effectiveness of time, chemicals and practical tools aspect:

In the aspect of effectiveness of time, chemicals and practical tools, there are 5 statements with a maximum average score of 25 and the average score obtained from the survey is 22.81 (positive category, score > 5).

Table 6. Aspect of effectiveness of time, chemicals and practical tools

ASPECT	STATEMENTS
Aspect of effectiveness of time, chemicals and practical tools	Making the practical more interesting to do because it uses tools and chemicals on a small scale
	Takes about 30 minutes for one try so it's more efficient
	It's fun because many experiments can be done with one component of the practical tool
	Understand chemistry lessons taught in a short time
	Makes me feel safe and comfortable doing practical in the classroom because the number of chemicals used is less so that less chemical waste is produced

In general, the practical tools used in the laboratory are made of glass, there is a high risk of permanent damage such as breaking. In the small scale chemistry, the practical tools mostly are made of plastic to reduce the risk of permanent damage during the practical work [2]. This causes small scale chemistry very much cheaper compared to using traditional laboratory glass equipment. The size of the tool is made smaller without changing or reducing its function, so that preservice chemistry students can conduct their own experiments conveniently. They can explore further about to improve their own skills in using traditional laboratory equipment. The ability needed in studying chemistry is not only understanding the theory, but the professionalism in doing practical is also needed [4].

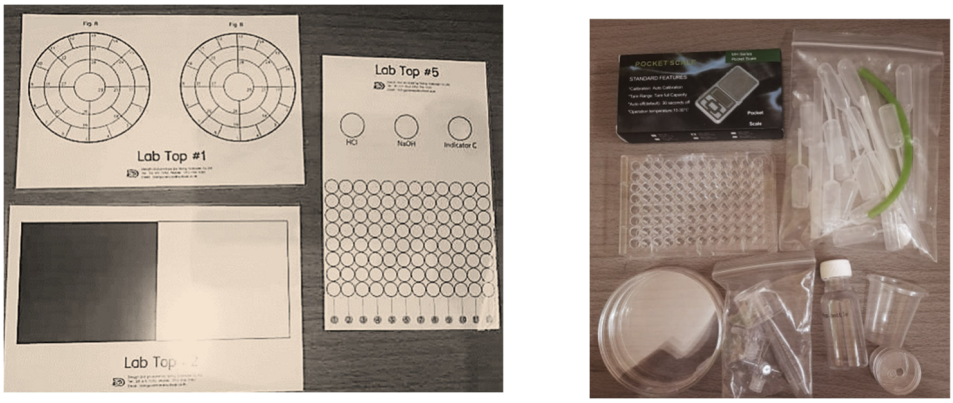


Figure 4. Small scale chemistry tools

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The other problem that often occurs in the laboratory is chemical wastes from practical work. These chemical wastes are toxic so they are dangerous to the environment [7]. The amount of chemicals used in small scale chemistry are much less, so the resulting wastes are also much less.



Figure 5. Chemicals in small quantities

The advantages of using small scale chemistry are higher safety levels, saving costs and time, environmental friendliness, preventing pollution, and easier to use equipment. Preservice chemistry students agree that small scale chemistry is very effective in time spending for each experiment because it is proven to them that they can be able to carry out many experiments in a short time, with an estimated time of 30 minutes for one experiment, including preparation and cleaning up when finished [12].

Self-confidence aspect:

In the aspect of self-confidence, there are 3 statements with a maximum average score of 15 and the average score obtained from the survey is 13.19 (positive category, score > 9).

Table 6. Aspects of self-confidence

ASPECT	STATEMENTS
Self-confidence	Understand that the topic of this practicum is related to everyday life
	Increase my confidence to use technology in learning activities
	Increase my confidence when guiding the practicum in front of students later

Small scale chemistry can increase the self-confidence of preservice chemistry students to conduct or guide practical activities because it is easy to use, safe, and can connect theoretical concepts with practice by timely observations. This is in accordance with research conducted by Tole [11] which showed 60.3% of students agreed that the topic of practical using small scale chemistry is related to everyday life and there are activities that involve chemical processes, so that chemical processes do not only occur in the chemical laboratory or in industry but in everyday life too.

The score of individual respondents:

Analysis of the scores from each respondent on all aspects asked, we found that the survey results show the highest response score of 90 and the lowest response score of 72 (see **FIGURE**

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6). The total average response was 82.89 indicating a high score in positive category. This shows that preservice chemistry students significantly satisfy with this small scale chemistry workshops in terms of interest and self-motivation, knowledge, skills, time effectiveness, chemicals, and practical tools, as well as self-confidence aspects.

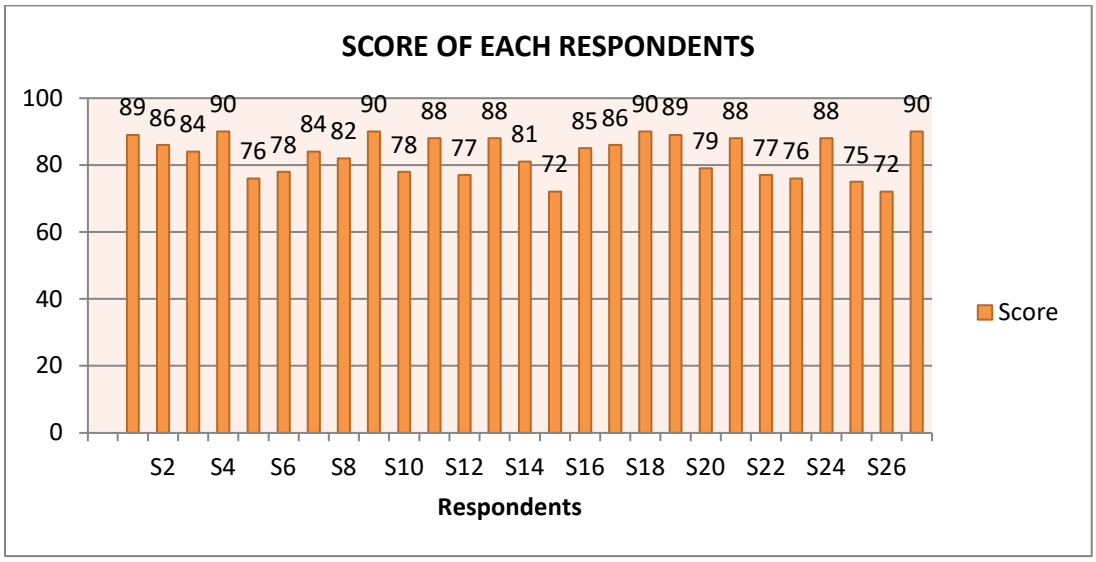


Figure 6. Distribution of score of preservice chemistry students' responses

Conclusion

The preservice chemistry student's responses to the small scale chemistry workshop activity was very positive, it could increase students' interest and self-motivation, knowledge, skills and self-confidence. The small scale chemistry workshop also shows that this activity pays attention to the effectiveness of time, chemicals and practical tools.

Acknowledgments

We thank the preservice chemistry students and chemistry teachers throughout North Sumatra for their participation. We acknowledge the Department of Chemistry, FMIPA leaders, UNIMED leaders who have facilitated small scale chemistry workshops. We are grateful to The Chemical Society of Thailand for their academic and technical supports, and to Bangkok Bank Public Co., Ltd., Thailand and Permata Bank Medan for the financial support.

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Development of chemoentrepreneurship (CEP) based learning module on colloidal system material for high schools

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Abstract . *In this study, a Chemo-entrepreneurship (CEP)-based Colloidal Chemistry Module was created, which is a contextual chemistry lesson. The teaching materials are then validated by 2 Lecturers and 1 Teacher as the validator of the learning module. Material validation by material expert validators consisting of two UNIMED chemistry lecturers and one chemistry teacher at SMAN 2 Medan according to the BSNP standard, obtained an average content feasibility aspect of 3.55, language feasibility aspect of 3.9 and contextual assessment 3.83 which means the results of material validation indicates that this module is valid and does not need to be revised. Meanwhile, media validation by a media expert validator consisting of 2 UNIMED chemistry lecturers and one chemistry teacher at SMAN 2 Medan showed that the feasibility of graphics had an average of 3.8 and language feasibility had an average of 3.58, which means that it is feasible and does not need to be revised. The trial was conducted at SMA Negeri 2 Medan using 2 classes as the experimental class and the control class. Learning with the experimental class uses a colloid system chemistry module that has been developed based on chemoentrepreneurship and the*

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control class uses a student handbook. It is obtained that the calculation of the percentage increase in learning outcomes (% gain), shows the increase in the value of the experimental class and control class increases is 71% and 59% respectively. Based on the results of the student response questionnaire to the chemoentrepreneurship-based chemistry learning module on colloidal system material, an average of 92.81% was obtained. It can be seen that students are satisfied and can understand better by using chemoentrepreneurship-based chemistry learning materials on colloidal system materials.

Keywords: Modul, koloid, chemo-entrepreneurship

Introduction

Teaching and learning activities can occur anytime and anywhere. One sign that someone is learning is a change in behavior in that person which may be caused by a change in the level of knowledge, skill or attitude. The interactions that occur during the learning process are influenced by the environment, one of which is a source of learning [9]. Learning resources provide learning experiences and without learning resources it is impossible to carry out the learning process properly. In short, learning resources can be formulated as something that can be used to support and facilitate the learning process [5].

One of the efforts that can be made to prepare high school students to enter the world of work is to equip them with entrepreneurial skills. The goal is for the paradigm of students' thinking to change from being employee-oriented to being willing and able to become entrepreneurs, namely by integrating entrepreneurship education into several subjects taught in schools [6].

Chemistry is a subject that has the potential to be developed into entrepreneurship. We can find various applications of chemistry in everyday life, one of which is the colloid system material. Generally, the products that we consume daily are in the form of colloids. For example, milk is a drink that is often consumed by various levels of society. This type of emulsion colloid is known as a highly nutritious drink which is not only sourced from animals but we can also make it ourselves using ingredients from plants such as corn and beans. We can sell this dairy product and become a business opportunity. The entrepreneurial approach in chemistry is called the Chemo-Entrepreneurship (CEP) approach. The CEP approach allows students to learn the process of processing a material into a product that has economic value and fosters an entrepreneurial spirit [8]. The use of the CEP approach in chemistry is expected to increase the ability of students to apply chemistry which is usually abstract in nature to a reality by producing a product that has economic value so that students become accustomed to it and can ultimately motivate them to become entrepreneurs [4].

According to the results of interviews with teachers of SMA Negeri 2 MEDAN, Chemistry learning at SMA Negeri 2 Medan has not emphasized providing learning experiences through developing skills and creativity. The true meaning of studying chemistry is an attempt to find out various phenomena or natural phenomena in order to get something useful for life humans [10]. This educational paradigm is designed to develop competencies that are in accordance with developing needs such as character education, active learning methodologies, a balance of soft skills and hard skills, and entrepreneurship which have not been properly accommodated in the curriculum [11].

Methodology

The development of this module was carried out at the Chemistry Department of Medan State University and then implemented at Medan 2 State High School which is on Jalan Karangsari

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No.435, Sari Rejo, Medan Polonia District, Medan City North Sumatra, Medan 13 State High School which is on Jalan Karya Bersama, Titi Kuning, Medan Johor District, Medan City, North Sumatra and Angakasa High School Soewondo Airbase Medan, Jalan Polonia, Medan Polonia District, Medan City.

The population in this study was divided into 2, namely the first population for the module (1) Several textbooks circulating in Medan City, (2) Lecturers in the Chemistry Department of Medan State University who teach General Chemistry, (3) Teachers involved in SMA Negeri 2 Medan who teaches chemistry, and the second is SMA Class XI IPA students at SMA Negeri 2 Medan for the 2021/2022 academic year.

The sample in this study was divided into 2, namely the first sample for the module (1) A total of 3 chemistry textbooks, (2) A total of 3 Chemistry Lecturers who had taught general chemistry, (3) A total of 1 chemistry teacher at SMA Negeri 2 Medan, and the second, namely 2 high school students in class XI IPA SMA Negeri 2 Medan. The sampling of textbooks, lecturers, and chemistry teachers was carried out by porposive sampling, while student samples were taken by random sampling.

Teaching material analysis

Guided by the 2013 curriculum syllabus, the next step is to conduct an analysis of the three teaching materials (high school chemistry books), the teaching materials are coded A, B and C. The following explains the reasons for choosing the three books that have been analyzed.

Table 1. Types of teaching materials analyzed

Type Of Book	Reasons for choosing a book
A	This book is often used as a chemistry teaching material at the high school level
B	This book is often used as a chemistry teaching material at the high school level
C	This book is often used as a chemistry teaching material at the high school level

Analysis of teaching materials carried out specifically on colloid system material with the following scope: (1) Definition of colloids, (2) Classification of colloids, (3) Properties of colloids, (4) Preparation and purification of colloids, (6) Uses of colloids in everyday life daily. After analyzing the teaching materials, the advantages and disadvantages of each teaching material are obtained which form the basis of the learning module design materials.

Design and development of instructional materials

After analyzing the book, the next stage is the design and development of teaching materials. The design of teaching materials is based on the 2013 syllabus and the analysis of the three chemistry books that have been carried out, so that the proposed metric components are according to standards. The advantages of each book were taken to be used in the design and development of chemoentrepreneurship-based learning modules which added several references from the internet that were appropriate and supported teaching materials [3].

Teaching materials developed based on Chemoentrepreneurship and adapted to the 2013 curriculum, learning modules are prepared by discussing material, supplemented by practice questions, as well as competency tests which are presented at the end of the chapter. The application or application of the colloid system in everyday life is presented with pictures that can foster student interest and clarify the relationship between material content and the real world, exposure to chemical figures and chemical info which aims to provide additional

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information for students and is equipped with simple practicums that later the final results of the practicum can be entrepreneurial by students in accordance with the objectives of making chemoentrepreneurship-based modules. There is also a summary at the end of the chapter, a glossary, an index, answer keys and the periodic system of elements [6].

Calculation of the average where the number of validator/test subject answers is divided by the number of validators/test subjects. Assessment is in the form of a score, namely 4 (strongly agree), 3 (agree), 2 (disagree), 1 (strongly disagree).

Table 2. Material validation results of chemoentrepreneurship-based learning modules

Number	Evaluation	Evaluation component	Score from Lecturer	Score from Teacher	Average
1	Aspect Content eligibility	Compatibility of Material with KI and KD	3,2	3,6	3,4
		Material Accuracy	3,4	3,5	3,45
		Material Update	3,75	4	3,8
		Encourage Curiosity	3,75	4	3,8
		Developing Proficiency *lifeskill.*	3,8	4	3,9
		Average	**3,58**	**3,82**	**3,55**
2	Aspect language eligibility	Serving Technique	4	4	4
		Presentation Support	3,5	4	3,75
		Presentation of learning	4	4	4
		Coherence or coherence flow of thought	3,75	4	3,87
		Average	**3,81**	**4**	**3,9**
3	Evaluation Contextual	Contextual Nature	3,75	4	3,87
		Contextual Component	3,60	4	3,8
		Average	**3,67**	**4**	**3,83**

From table 2 it can be seen the results of material validation by material expert validators consisting of two UNIMED chemistry lecturers and one chemistry teacher at SMA N 2 Medan according to the BSNP standard, including: aspects of content eligibility with a total average of 3.55 which means valid or not needs to be revised, the aspect of language feasibility is 3.9 which means it is valid and does not need to be revised, contextual assessment is 3.83 which means it is feasible and does not need to be revised [2].

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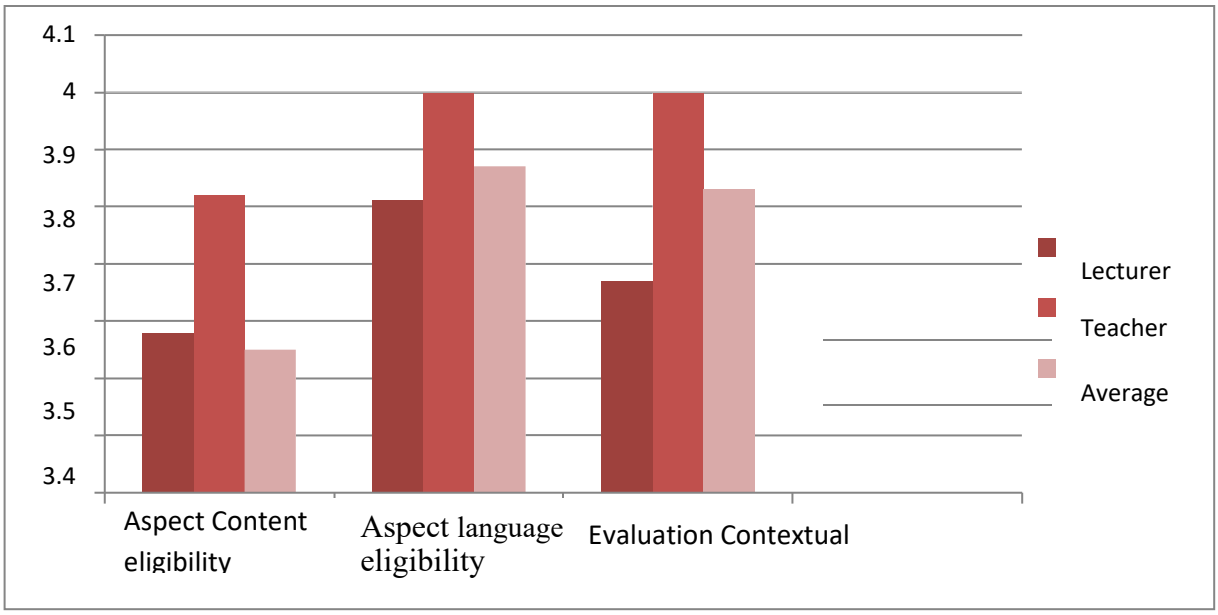


Figure 1. Differences in the results of the material expert validator's assessment of chemoentrepreneurship-based learning modules

Media validation

The media validation was taken from the validator who came from one teacher and two UNIMED chemistry lecturers who were the same as the media expert validator. The data analysis technique used is the average calculation where the number of validator/test subject answers is divided by the number of validators/test subjects. Assessment is in the form of a score, namely 4 (strongly agree), 3 (agree), 2 (disagree), 1 (strongly disagree).

From table 3 it can be seen the results of media validation by media expert validators consisting of UNIMED chemistry lecturers and one chemistry teacher at SMA N 2 Medan, namely graphic feasibility has an average of 3.8 which means it is feasible and does not need to be revised, and language feasibility has an average the average is 3.58 which means it is feasible and does not need to be revised.

Table 3. Results of chemoentrepreneurship-based chemistry learning module media validation

No	Aspect	Component	Score		Average
			Lecturer	Teacher	
1	Aspect of graphics Feasibility	Size of module	3,2	3,6	3,4
		Modul cover design	3,4	3,5	3,45
		Modul content design	3,75	4	3,8
		Average	3,75	4	3,8
2	Aspesct of language feasibility	Easy to know	3,4	4	3,7
		communicative	3,8	4	3,9
		Dialogic and interactive	3,3	4	3,6
		Compatibility with student development	3,5	4	3,7

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		Compliance with the rules language	3,3	3	3,1
		Use of terms, symbols or icon	3,6	3,5	3,5
		Average	3,4	3,75	3,58

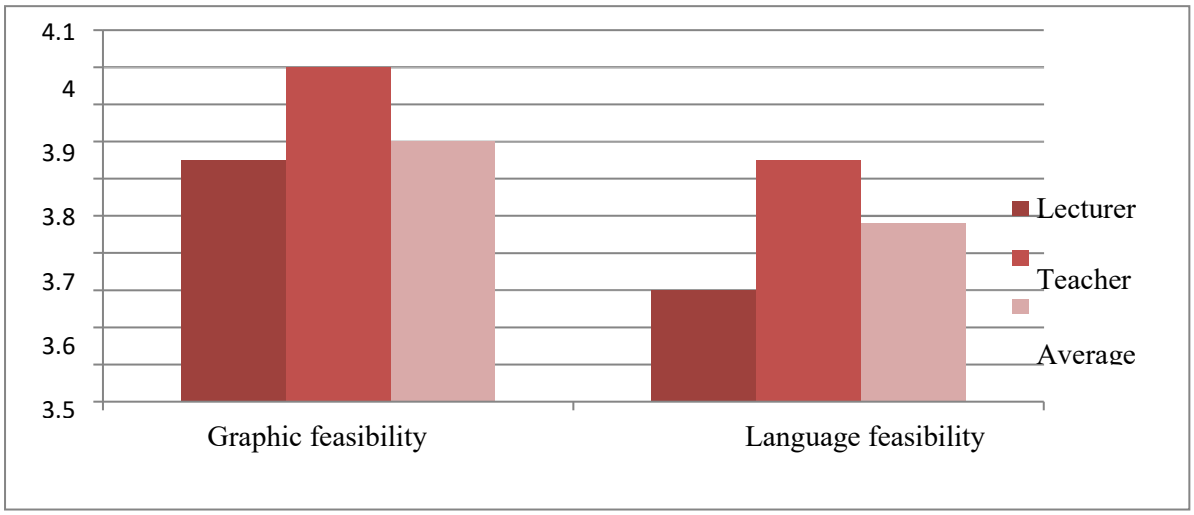


Figure 2. Graph of the difference in the results of the assessment of the material expert

Student Responses to Learning Modules

The respondents of this study were students in the experimental class who were taught a chemoentrepreneurship-based learning module. First, students read, understand and assess the teaching materials that have been developed based on appearance aspects, material aspects and benefits aspects.

In this study a non-test instrument was used with 10 statement items using a scale of 1-4 with very feasible, feasible, inappropriate and very inappropriate answer choices for chemoentrepreneurship-based teaching materials on colloidal system material.

Table 4. Percentage of student satisfaction with chemoentrepreneurship teaching materials.

Number	Assessment Aspect	Pecentage of Satisfaction Level
1	Display Aspect	93,75 %
2	Material Aspect	91,67%
3	Benefits Aspect	93%
Average		92,81%

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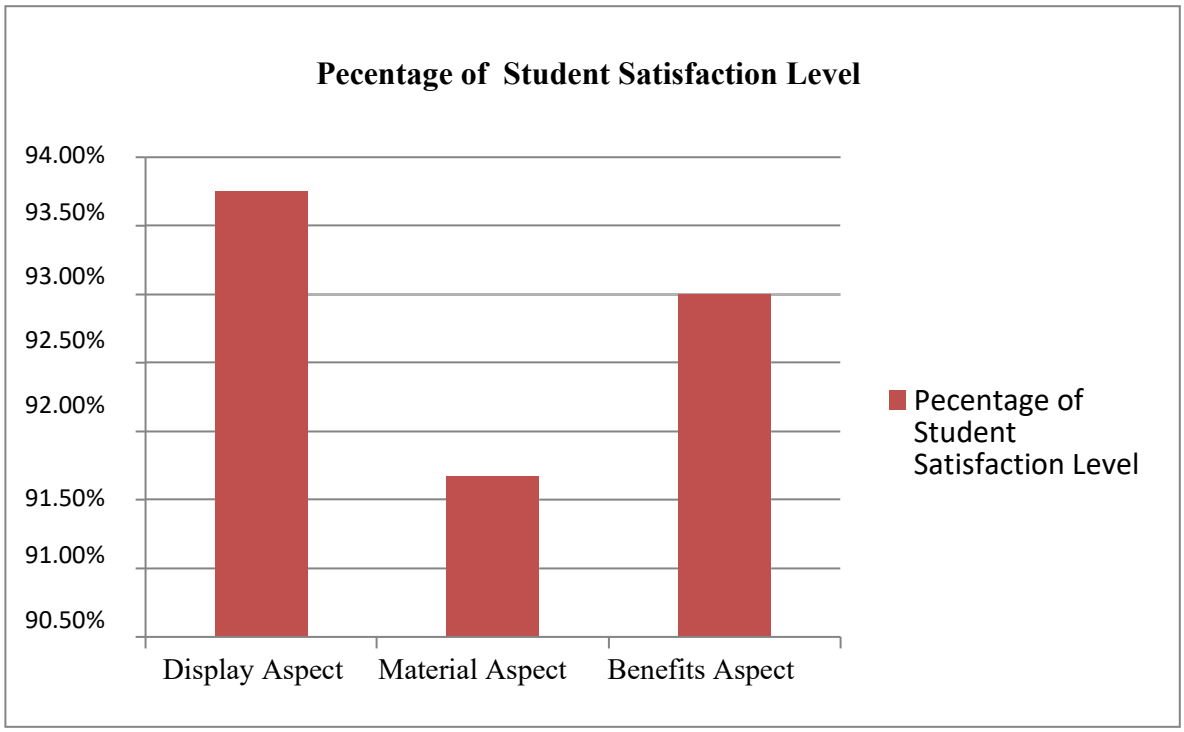


Figure 2. Percentage graph of student satisfaction levels with chemoentrepreneurship based learning modules

Based on the results of the student response questionnaire to the chemoentrepreneurship-based chemistry learning module on colloidal system material, an average of 92.81% was obtained. Based on these results it can be seen that students feel satisfied and can better understand by using chemoentrepreneurship-based chemistry learning materials on colloidal system material.

Conclution

Modules that have been developed and validated by a team of chemistry lecturers and chemistry teachers have valid results and do not need to be revised so that the module can be used immediately. Student responses to the colloid module that has been developed are very positive and this module is easy to understand so that students are more interested in learning chemistry.

Acknowledgments

We thank the preservice chemistry lecturer and chemistry teachers in SMAN 2 Medan, North Sumatra for their participation. so that this colloid module can be completed and can be used in the learning process

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Analysis of Product Dimension Creativity Competency Through Green Chemistry Project Based Learning in the Independent Curriculum

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Abstract. *This study aims to analyze creativity competence in the dimensions of class X students at senior high school 71 Jakarta through the application of Project Based Learning (PjBL) for Green Chemistry in the Independent Curriculum. The population in this study were all students of Public senior high school 71, with purposive sampling technique, the sample selected in this study used two classes with a total of 60 students consisting of 33 people in the experimental class who applied PjBL and 27 people in the control class who did not apply PjBL. The instrument used in this study is a product assessment rubric that has been validated by an expert validator. Valid instruments were used in the study, the data obtained were presented in tabular form. The results of the analysis of the product assessment showed that there were differences in the creativity competence of the experimental class and the control class (sig < 0.05). This is also evidenced by the average Product Dimension Creativity competency score in the experimental class of 81.58, while in the class of 72.59.*

Keywords: project, green chemistry, product, creativity, independent curriculum

Introduction

The process of implementing the independent curriculum at the senior high school level as a whole is an attempt by the government to restore learning. This is motivated by the occurrence of learning loss during the pandemic [1]. The legal basis for implementing this curriculum includes the Decree of the Minister of Education, Culture, Research and Technology of the Republic of Indonesia Number 56/M/2022 concerning guidelines for implementing the curriculum in the

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context of learning recovery [2]. Even though the central government has not made it mandatory for schools to implement the Independent curriculum, there are already around 140,000 schools that have signed up to implement the independent learning curriculum [3]. Schools that feel they are not ready are still allowed to use the old curriculum, namely the 2013 curriculum or the emergency curriculum in implementing education in their educational units [4]. State Senior High School 71 Jakarta is the first school in East Jakarta to implement an independent curriculum, so there are no pilot schools implementing their curriculum for this school.

The implementation of the independent curriculum for the first time at senior high school 71 Jakarta was carried out in 2020 and only in class X, for class XI and XII still using the 2013 curriculum until graduation. This curriculum change is a challenge for teachers because in addition to changing the learning system, teachers also have to make adjustments to the material in accordance with the achievements in the curriculum, as well as when requiring material adjustments in accordance with the achievements in the curriculum [5]. Learning by implementing an independent curriculum follows the latest material arrangement that is different from the 2013 curriculum material composition, because basically curriculum changes must change the structure of learning materials [6]. The structure of the 2013 curriculum material for first semester is Introduction to Chemistry, atomic structure, periodic system, chemical bonds and Electrolyte and Non-Electrolyte Solutions, while the material structure in the independent curriculum for first semester is green chemistry, global warming, reaction equations, compound nomenclature and so on.

The beginning of learning chemistry in the independent curriculum is green chemistry material. This learning objective was formulated to overcome the global challenges of climate change and energy limitations by designing processes to maximize the efficient use of the earth's limited resources [7]. In general, the chemistry material for class X of the Independent Curriculum is designed so that students learn by finding problems, making hypotheses, designing simple experiments, conducting experiments, analyzing data, drawing conclusions and communicating experimental results both in writing and orally [8]. To achieve these skills, the teacher must be able to implement various learning strategies [9], learning models [10], learning approaches [11], teaching materials [12], learning media [13].

Project based learning is a student centered learning approach that focuses on science process skills. The correct implementation of project based learning [14] and according to the syntax [15], has an impact on increasing the competence of students related to science process skills. One of the competencies of students that must be the focus in the 21st century is the creativity of students. Increasing creativity is one part of the assessment of the science process skills [16]. Creativity consists of 4 dimensions, namely person, press, process and product. In the assessment of chemistry learning, there has been no overall assessment of the four dimensions of creativity, this causes the creativity assessment to be biased and incomplete [17]. In order for the assessment to be unbiased, an assessment per dimension [18] must be carried out using a valid assessment rubric for each dimension [19]. Previous research studies have focused a lot on the dimensions of creativity, so this research will specifically assess the dimensions of students' creativity products in chemistry learning by implementing PjBL using a valid assessment rubric.

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Methodology

The design of this research is a simple experimental design (Posttest Only Control Group Design) [20], as presented in table 1 below:

Table 1. Research design

Group	Treatment	Post Test
Experiment 1	X	O2
Experiment 2	Y	O2

Information:
X : Project Based Learning (PjBL)
Y : Conventional Learning
O2 : Post Test

The location for the research was carried out at senior high school 71 which is located at Kavling TNI Navy, RT.7/RW.16, Duren Sawit, Duren Sawit District, East Jakarta City. All of students in SMAN 71 are the population in this study. Sampling in this study using purposive sampling technique [21], the sample of this research is class 10 MIPA 2 as many as 33 people and 10 MIPA 3 as many as 27 people. This research was conducted on 21 July 2022 to 11 August 2022. Research activities started from initial observation, preparation of proposals, preparation of lesson plans and assessment rubrics, validation of assessment rubrics, implementation of PjBL, assessment of students' product dimensions of creativity, data analysis and preparation of research reports . The tests used were posttest after students completed the project, using the rubric of products dimension the students' creativity according to table 2 below:

Table 2. Project completion rubric

Rated components	Criteria	Score
Topic	According to learning material, rational, contextual	5
	According to learning material, original, not contextual	4
	According to learning material, unoriginal, contextual	3
	Appropriate learning material, not original, not contextual	2
	Not according to learning material, not original, not contextual	1
Project Diagram	Reflects the relationship, there is a chance of discovery	5
	Reflect relationship, no chance of discovery	4
	Does not reflect the relationship, there is a chance of discovery	3
	Does not reflect the relationship, there is a chance of discovery	2
	Not making diagrams	1
Project Process Stages	Complete, systematic, methodological	5
	Complete, less systematic, methodological	4
	Complete, systematic, lessmethodological	3

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	Complete, less systematic, less methodological	2
	Inomplete, less systematic, less methodological	1
Monitoring	According to the stages of the project, the schedule is clear, there is a progress sheet	5
	According to the stages of the project, the schedule is clear, there is no progress sheet	4
	According to the stages of the project, the schedule is not clear, there is a progress sheet	3
	According to the stages of the project, the schedule is not clear, there is no progress sheet	2
	Not according to project stage	1

The valid instruments above (table 2) were used as instruments in this study. The data obtained are presented in the form of a descriptive data table and then analyzed for the difference in the average product score for the experimental class 1, namely the application of PjBl learning and experiment 2, namely the application of conventional learning by converting the score to a scale of 100 [22], and then analyzed per product dimension indicator on creativity skills. students, so that the results of the study are more detailed [23].

Result and discussion

Based on the data obtained in the study, a descriptive statistical test was carried out using the help of SPSS 25. The results of the descriptive test obtained information as presented in table 3 below:

Table 3. Descriptive statistics

Class	Mean	Std. Deviation	N
Experiment 1	81.58	11.78	33
Experiment 2	72.59	8.28	27
Total	77.53	11.22	60

Based on table 1 above, the average Product Dimension Creativity competency score in the experimental class of 81.58, while in the class of 72.59. Based on the data that the researcher has collected and processed as planned, the researcher tries to describe the results and discussion of this research. This study aims to analyze the dimensions of creativity possessed by students of senior high school 71 Jakarta. In this case, the researcher found various supporting facts related to the analysis of the dimensions of student creativity.

The fact that the Covid-19 pandemic is also one of the causes of the emergence of various creative ideas and innovations by students. This is in line with the press dimension which states that the environment greatly affects one's creativity [24]. This causes students to more quickly find creative solutions to problems that are happening. This is because students see the problems that occur too often, so that a sense of responsibility for these problems grows. Indirectly it

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fosters motivation and self-confidence of students to be able to take a valuable step for solving the problems at hand [25].

Various studies concluded that the implementation of project-based chemistry learning can contribute to student learning achievement [26], specifically to student creativity [27]. This is because the project-based learning syntax facilitates students to learn creatively [28] independently in developing a product related to chemistry learning materials. The product as one of the dimensions of student creativity consists of 4 indicators in this study, if it focuses on the experimental class 1, then the distribution of scores on each indicator is presented in Figure 1 below:

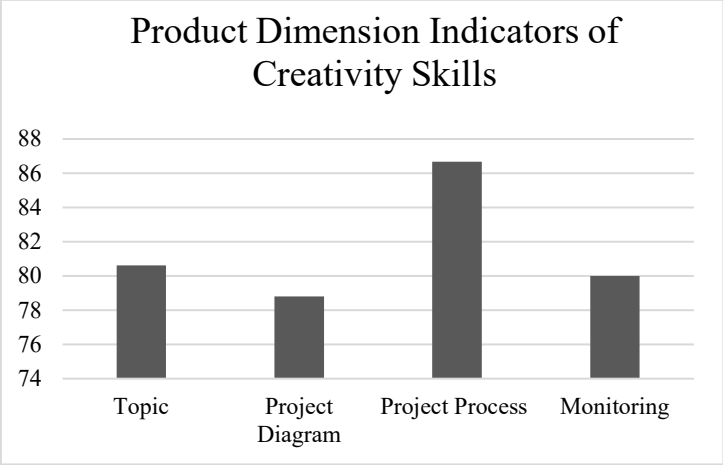


Figure 1. Product dimension indicators of creativity skills

Based on Figure 1 above, it can open the creativity of students, the product dimensions in each indicator are almost evenly distributed. The higher indicator is the project process indicator. This is in line with the results of previous studies which showed that in the project process indicators, students tend to be very active and enthusiastic [29]. Creativity in the process of making products in chemistry learning is influenced by understanding the material [30], the creativity of prospective teachers to design simple practicums [31]. The second indicator with the highest score is the topic indicator, this is due to the creativity of someone who thinks creatively a student [32] in accordance with the curriculum and material taught by the teacher [33]. Skilled in reporting products, making projects, and can produce creative products related to the right technique [34].

Conclusion

Through this research it is concluded that there were differences in the product's dimension of creativity competence of the experimental classs and the control class.

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The development of project-based learning resources to build higher order thinking skills in teaching isolation and purification of alkaloid compounds

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Abstract. *The availability of innovative learning resources is the key to the success of active learning in achieving competence according to the curriculum targets. The purpose of this study was to develop project-based innovative learning resources on teaching the isolation and purification of alkaloids compounds to build higher order thinking skills as a strategy for achieving competence in the field of analytical chemistry. This research was carried out through developing innovative learning resources integrated with mini projects, standardizing learning resources, and implementing them for teaching the analysis of organic compounds. The research product has been obtained in the form of a standard project-based innovative learning resource package for teaching Isolation and Purification of Alkaloid Compounds. Learning resources are proven to be effective in guiding students to learn to separate organic compounds, and to practice the isolation and purification techniques of organic compounds contextually. Students successfully plan and carry out their own projects to separate, purify and identify alkaloid compounds contained in various types of plants. Higher order thinking skills have been developed as a strategy for achieving competence in the field of analytical chemistry. Subjective scores of the fortopolio of project proposals (M=83.15±1.71) and project reports (M=86.57±1.74), as well as objective assessment of learning outcomes (M=83.04±6.49), all are in the very good category. Project-based learning motivates students to actively learn to use learning resources in building higher order thinking skills and increasing knowledge in the field of Analytical Chemistry.*

Keywords: learning resources; project-based learning; alkaloid isolation; HOTS; thinking skills

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Introduction

A complete package of learning resources is the key to the success of students learning actively in achieving the competency targets set in the curriculum. The availability of innovative learning resources that can guide students needs to be fulfilled, especially those that can support blended learning that is relevant to the subject being studied, including teaching Analytical Chemistry [1,2]. Analysis of organic compounds needs attention in equipping students with the knowledge and skills of contextually separating, identifying, and determining target analytes [3,4]. Knowledge in analytical techniques will provide experience in the field of isolation, identification and confirmation, and determination of organic compounds obtained through lectures and laboratory activities [5,6]. The problem faced is the difficulty in achieving competence in the field of organic compound analysis because it must combine knowledge and laboratory skills that can be achieved through the availability of innovative learning resources [7]. Thus, it is necessary to innovate learning through providing learning resource packages to facilitate students learning the analysis of organic compounds by adjusting classroom conditions to optimize learning potential in increasing the knowledge and skills required by chemists [8,9]. Knowledge of isolating and purifying alkaloid compounds should be mastered as part of phytochemical studies [10-12].

Innovation in education is very relevant to be done to improve student competence. Learning innovations have been proven to be effective in teaching at universities in normal learning situations as well as abnormal situations referring to the experience in subnormal learning due to the Covid-19 pandemic in the last two years, namely in the global situation of implementing social restrictions in face-to-face learning to break the transmission of the corona virus. [13]. The application of project-based learning is a good strategy to be able to optimize independent learning to conduct investigations [14,15]. To make project-based learning run optimally, innovative learning resources are needed that can be used by students to learn systematically through the implementation of their projects to build thinking skills as a strategy to increase their knowledge in the subjects they study [16]. The strategy in encouraging students to learn actively is to implement project-based learning with a focus on the isolation and purification of alkaloid compounds from medicinal raw materials contained in plant samples. This study aims to develop project-based innovative learning resources and implement them in contextual teaching of the isolation and purification of alkaloid compounds to build higher-order thinking skills as a strategy in increasing knowledge and analytical skills in achieving competence in the field of Analytical Chemistry.

Methodology

Research sample

This research was conducted involving 25 students of Chemical Studies Program, Universitas Negeri Medan, namely students who took the Organic Analytical Chemistry course. The research implementation has followed the research code of ethics that has been set by the university. Respondents were given an explanation of the research objectives, and first obtained approval from students to be used as research samples, and were given the freedom to withdraw at any time if needed and did not affect the assessment in the courses being followed.

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Research procedure

The stages of research carried out include needs analysis, development of learning resources, and implementation of project-based learning. The first stage is carried out to analyze the need for learning resources for the Organic Analytical Chemistry course in accordance with the competency-based curriculum oriented to the Indonesian National Qualifications Framework (KKNI). Analysis of teaching materials is focused on the suitability of teaching materials to student learning needs based on curriculum targets. The next stage is developing learning resources on the subject of Isolation and purification of Alkaloid Compounds through enrichment of teaching materials, integrating project packages and multimedia for the implementation of organic compound analysis, and providing supporting tools for project implementation. Standardization of developmental learning resources using expert lecturers is carried out at the next stage, namely by asking for opinions from experienced lecturers who have taught courses for at least three consecutive years. The components asked were about the feasibility of the learning resource package for teaching Isolation and Purification of Alkaloid Compounds in universities, and their opinions were used as input to correct deficiencies found in the Organic Analysis Chemistry teaching learning resource kit, which was called an innovative learning resource package.

The next stage is the implementation of project-based learning resources in the teaching of Organic Analytical Chemistry. Teaching is carried out sequentially through the implementation of a preliminary test (pretest) and followed by the implementation of teaching for providing basic theory through zoom lectures, providing explanations on how to use learning resources and the university's e-learning system (SIPDA), giving project assignments and project product targets that must be achieved. in courses, evaluation of learning outcomes and screening of student opinions on all stages of learning. To optimize the potential for independent learning, explanations are given on using online learning resources and links to relevant teaching materials, examples of project implementation videos, discussions, mentoring, and assessment of learning outcomes entirely through the university's SIPDA e-learning tool. The achievement of student competence in the field of organic compound analysis is measured using an assessment of learning outcomes and evaluation of learning outcomes. Students' learning motivation using project-based learning resources was also investigated at the end of the lecture by giving questionnaires to respondents.

Results and discussion

Inovative learning resource package

To support project-based learning for teaching Organic Compound Analysis, a complete learning resource package has been developed integrated with a mini-project for the subject of Isolation and Purification of Alkaloid Compounds as summarized in Table 1. Teaching materials are arranged according to student needs based on a competency-based curriculum. The subject of isolation and purification of Alkaloid compounds consists of three sub-chapters, namely Introduction to Alkaloid Compounds, Isolation Techniques of Alkaloids, and Identification of Alkaloid Compounds, which are accompanied by examples of mini-projects and relevant multimedia to support teaching. Learning resources consist of complete teaching materials on isolation, purification and identification of Alkaloid compounds, mini project packages, multimedia and video examples of project implementation of isolating, purifying, and identifying

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Alkaloid compounds all integrated with the sub-chapter of teaching materials. Each sub-chapter is hyperlinked to the relevant journal, equipped with student worksheets for the implementation and observation of isolation, purification and identification, and packaged into an innovative learning resource package to help students learn actively independently.

Table 1. Description of the innovation of the learning resource package, and project title on teaching of isolation and purification of alkaloid compounds.

No	Sub Subject	Learning Rosources Innovation	Supplements
1	Introduction to Alkaloid compounds	This sub-material consists of learning materials for alkaloid compounds, general properties of alkaloid compounds, classification of alkaloid compounds, and the use of alkaloid compounds. Teaching materials are equipped with learning videos and hyperlinks to articles in reputable journals about alkaloid compounds.	Multimedia about alkaloid compounds, isolation and their uses
2	Isolation of Alkaloids, Methods and Techniques	The isolation technique of alkaloid compounds consists of standard procedures for extracting alkaloid compounds from plant raw materials, including sample preparation, preparation of extraction equipment, extraction techniques using Soxhlet, procedures and stages of separation and purification of alkaloid compounds using chromatographic methods (thin layer chromatography and column chromatography). Teaching materials are equipped with videos and hyperlinks to scientific articles on the isolation of alkaloid compounds.	Project 1: Phytochemical screening of alkaloid compounds and isolation of alkaloids from plant leaves. Project 2: Isolation and purification of alkaloid compounds from medicinal plant leaves.
3	Identification, confirmation and quantification of alkaloid compounds	Identification of alkaloid compounds consists of qualitative analysis and quantitative procedures. Qualitative analysis was carried out using special reagents to ensure the presence of alkaloid compounds in the sample, and quantitative analysis was used to calculate the isolated alkaloid content in the sample. The identification technique of alkaloid compounds using FTIR and GC-MS is also provided in the study resource package.	Project 3: Qualitative identification of alkaloid compounds using special reagents. Project 4: Quantification of Alkaloid compounds contained in samples and how to calculate them. Project 5: Identification and confirmation of Alkaloids using FTIR and GC-MS analytical approaches.

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Standardization of innovative learning resource package

Project-based learning resource sets for teaching Alkaloid Isolation and Purification and their equipment have been standardized by experts, namely experienced lecturers, following the eligibility criteria for learning resources set by the National Education Standards Agency (BSNP). The feasibility of learning resources for the subject of Alkaloid Isolation and Purification based on the results of the respondents' assessments is summarized in Table 2. Each of the parameter components contained in the learning resources is feasible and qualifies as a learning resource in higher education. The average of the components of learning resources such as content depth, language feasibility, technical feasibility of presentation, and feasibility of project implementation instructions, and worksheets were stated to be very good by respondents (M=3.60±0.49).

Table 2. Results of standardization of project-based innovative learning resource packages for the subject of alkaloid isolation and purification, based on the assessment of expert respondents following the BSNP criteria.

No	Short Description of Learning Resources	Respondent Assesment* (M±SD), L (n=3)
1	**Completeness and depth of project-based learning resource**, including; (1) Teaching materials and mini-projects for isolating organic compounds are available and complete according to the achievement of the competency targets set in the curriculum, (2) The contents of teaching materials are arranged systematically and completely, consisting of: introduction, basic theory, project for isolation of alkaloid compounds , worksheets, observation sheets, report templates, and result presentation formats, (3) Examples of contextual organic compound isolation projects.	3,56 ±0.51
2	**Feasibility of language and legibility**, including: (1) Suitability and accuracy of the use of chemical terms with grammatical rules, (2) Accuracy of using symbols, formulas and chemical reactions, (3) Readability of teaching materials and mini project packages, and simplicity of learning messages.	3.65±0.48
3	**Presentation techniques**, including: (1) compatibility of illustrations, pictures and tables with narration and chemical material, (2) typing, layout, color selection, and integration of hyperlinks of articles from reputable journals in learning resources, (3) availability and suitability of facilities supporters with competency targets.	3.53±0.50
4	**Availability of project implementation instructions**, including; (1) Project implementation guidelines, (2) Completeness of worksheets, observation sheets, data collection and processing tools, (3) Project assessment rubrics (proposals and reports), and (4) Practice questions and answer keys.	3.67±0.47
	Average	3,60±0,49

Description: (4) Very appropriate; (3) Appropriate; (2) Not appropriate; and (1) Very inappropriate.

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Implementation of learning resources in teaching isolation and purification of alkaloids

The developed project-based learning resource has been implemented in the teaching of Alkaloid Isolation and Purification. Since this research was conducted during the Covid-19 Pandemic, namely the implementation of social restrictions to break the chain of virus transmission, blended learning was carried out as a combination of online and face-to-face learning in the laboratory, and all learning activities were modified according to the regulations set by the university. Academic activities include the implementation of an initial evaluation (prestest), online lectures using zoom meetings to deliver the theory of Alkaloid Isolation and Purification, project implementation and reporting, and evaluation of learning outcomes at the end of the lecture. Learning resource sets containing teaching materials, project packages and their supports are all uploaded to SIPDA. Students freely access SIPDA to download teaching materials, project examples, templates, and links to relevant scientific articles. The assignment product in the form of a project plan was uploaded by students at SIPDA, followed by input by the instructor to ensure the feasibility of the project plan and the names of the plants used as samples for the isolation of alkaloids. Projects can be carried out in the laboratory after obtaining approval from the instructor. Students have carried out their own projects (proposals and project reports) and have been assessed subjectively using the HOTS assessment rubric as summarized in Table 3.

Table 3. Subjective assessment of higher order thinking skills project activities (proposals and reports) isolation and purification of alkaloid compounds.

No.	Component HOTS	Description of thinking skills	Score (M±Sdv)	
			Project proposal	Project report
1.	Analisis	The ability to think analytically for solving problems in isolating and purifying Alkaloid compounds found in various types of plants includes: selection of plant parts as samples, sample treatment strategies, determining steps to isolate, purify, and identify alkaloid compounds	82.60±1.47	84.33±2.45
2.	Evaluate	bility to think systematically in evaluating project assignments for the isolation and purification of alkaloid compounds, starting from providing samples from plant parts, treating samples, choosing the right solvent for extraction, and identifying and confirming the isolated target alkaloid compounds.	82.64±1.66	85.17±2.67
3.	Create	Ability to determine the best method for isolating and purifying alkaloid compounds contained in various types of plant raw materials, skills in modifying extraction procedures and selecting the right solvent as a new technique for obtaining large amounts of alkaloid compounds at relatively lower costs.	84.20±1.80	85.70±1.74
Average			83.15±1.71	86.57±1.74

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* Obtained from a subjective project assessment using the criteria in the assessment rubric

Project-based learning innovations for teaching Alkaloid Isolation and Purification are carried out to optimize active learning for students according to the implementation of their planned projects. Students are directly involved in studying the isolation and purification techniques of alkaloids using plant samples. Higher order thinking skills are developed, including skills in analyzing, evaluating, and creating (Table 3).

The development of higher-order thinking skills is intended as a strategy to create an active learning atmosphere through optimizing student involvement in learning according to their abilities so that learning takes place holistically. Implementation of the project as a strategy in directing students to master knowledge and skills on the material of isolation and purification of alkaloids. The learning evaluation carried out from the implementation of the project shows the development of thinking skills, an increase in knowledge, which is shown in Table 4 as evidence of the achievement of competence in the field of analytical chemistry. The results of the subjective assessment of the project assignment portfolio (M=84.86±1.73) were classified as good. Student learning outcomes based on objective assessment obtained (M=85.43±4.35) were higher than the students' initial mastery (pretest) before the lecture (M=38.6±11.18). It can be stated that student learning outcomes are classified as good, and student competence in the field of organic compound analysis has been achieved.

Table 4. Student learning outcomes based on the assessment of student learning outcomes on the material for isolation and purification of alkaloids.

No.	Aspects of assessment	Learning outcome Score (M±Sdv)	Conclusion
1.	Pretest	38.6±11.18	Incompetent
2	Project assignments (combination of proposal score and project report)	84,86±1,73	Competent
3.	Posttest Score	83.04±6.49	Competent

Student motivation in project-based learning

Students' motivation to learn was captured during the implementation of project-based learning on the teaching of isolation and purification of alkaloids using innovative learning resources. The motivational components assessed include confidence, challenge, engagement, curiosity, relevance, and satisfaction as summarized in Table 5. Students gave positive responses to the components of teaching and learning activities. Project-based innovative learning resources in guiding students to learn actively independently in achieving competence in the field of organic compound analysis (M=3.82±0.39), which is classified as very high. Students are motivated to learn independently to carry out isolation and purification projects of alkaloid compounds, which are derived from project-based learning contributions.

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Table 5. Student learning motivation as the implementation of project-based innovative learning resources on the teaching of isolation and purification of alkaloids.

No	Motivation components	Description of learning motivation assessment	Respondents opinion* (n=25)
1	Confidence	Students' confidence is active learning, doing their own projects, and using innovative learning resources to study the isolation and purification of alkaloid compounds.	3,85±0,33
2	Challenge	Project-based learning challenges of isolation and purification of alkaloid compounds from medicinal plant raw materials to build skills and increase knowledge of organic compound analysis.	3,88±0,31
3	Engagement	Students are directly involved in carrying out their own projects to isolate and purify alkaloid compounds, starting from planning, implementing, reporting and presenting the findings of the alkaloids contained in the target sample.	3,88±0,34
4	Curiosity	Students' curiosity in finding the best analytical method to isolate and purify alkaloid compounds contained in medicinal plant samples	3,71±0,42
5	Relevance	Realization of competency targets with projects, adequacy and availability of learning resources and mini projects in helping students carry out isolation and purification of alkaloid compounds	3,89±0,44
6	Satisfication	The level of student satisfaction in using the learning resource package and its supporting tools to help students learn actively to build knowledge and higher-order thinking skills in the teaching of isolation and purification of alkaloids.	3,72±0,47
		Average	3,82±0,39

*Likert scale with 4 answer choices: (4) Strongly Agree; (3) Agree; (2) Disagree; and (1) Strongly Disagree

Discussion

Active learning is very appropriate to be implemented in higher education because students have academic maturity to learn in achieving the competency targets needed in their careers after completing their studies [17,18]. To facilitate student learning optimally, relevant learning resources are needed. The availability of innovative learning resources is the key to student success in developing knowledge and skills, including in studying Analytical Chemistry [19,20]. Complete learning resources will guide students to learn optimally in achieving the competencies targeted in the curriculum. Learning strategies through the provision of innovative learning resources have been successfully carried out for teaching chemistry, namely through integrating academic activities in learning resources to guide students to learn actively including problem-

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based learning, through assignments, case studies, projects, and inquiries [21-23]. Project-based learning is proven to be appropriate in involving students to improve the knowledge and skills needed as life skills.

Project-based learning resources for teaching the isolation and purification of alkaloid compounds carried out in this study are designed to improve higher-order thinking skills with the aim that students master science concepts holistically [24,25]. The teaching materials in the learning resources are systematically arranged to meet the needs of students in increasing knowledge in the analysis of organic compounds [26]. Examples of project and multimedia packages designed for online and offline learning guide students to learn independently. Through the availability of learning resources, students are able to plan and implement a contextual alkaloid isolation project. The learning resource package is effective in guiding students to study the analysis of organic compounds. Students succeeded in planning, implementing, reporting and presenting their assigned alkaloidal isolation project assignments. The theory of isolation and purification of alkaloid compounds was mastered and higher order thinking skills in the aspects of analyzing, evaluating and discovering were also developed [27]. Analytical abilities have been developed as evidenced by the success of students in isolating and purifying Alkaloids contextually. The ability to evaluate the task of isolation and purification projects of Alkaloid compounds that are appropriate in the extraction procedure has been found to produce the maximum amount of Alkaloid target compounds. New discoveries in the isolation technique of Alkaloids have resulted from the success in modifying the extraction procedure and selecting the right solvent to isolate large amounts of Alkaloids at relatively low cost.

Student involvement in learning is strongly influenced by intrinsic motivation, and is very decisive in achieving competency targets [28]. An investigation of teaching and learning activities has been carried out, it is found that project-based learning motivates students in studying the analysis of organic compounds. The availability of innovative learning resource packages encourages students' desire to carry out their own projects to isolate and purify Alkaloid compounds as a strategy in building critical thinking skills and holistically will increase students' knowledge [29]. Innovative project-based learning resources have increased student interest in studying the analysis of organic compounds as one of the targets of competence in the field of analytical chemistry required by chemists. It can be stated that project-based innovative learning resources are very appropriate to be implemented for active learning in achieving student competencies as life skills after completing their studies.

Conclusion

Project-based learning is equipped with innovative learning resources that are appropriate to use in increasing competence in the Organic Compound Analysis course. The availability of learning resources facilitates students to learn actively to build higher order thinking skills as a strategy for achieving competence in the field of analytical chemistry. The teaching materials consist of three sub-chapters equipped with mini projects, multimedia, and learning support devices that are compatible for blended learning, guiding students to carry out projects to isolate and purify Alkaloid compounds from medicinal plant raw materials. Expert respondents considered that the learning resource package was very good and feasible for higher education (M=3.60±0.49). Implementation of learning resources in the classroom is effective in guiding students to learn the analysis of organic compounds, optimizing student involvement in planning and

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implementing projects for isolation and purification of alkaloids from medicinal plants. The results of the subjective assessment of the project assignment (M=84.86±1.73) and the objective assessment of knowledge (M=85.43±4.35) were all good, and competence in the field of organic compound analysis was achieved. Students are motivated to learn through project implementation using innovative learning resources (M=3.82±0.39). This learning model is appropriate to build thinking skills as well as strategies to increase knowledge, and can be done to support online and offline learning.

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Effects of Guided Inquiry Learning Models in Improving Students' Scientific Process Skills and Learning Outcomes for Thermochemical Materials

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Abstract. *The purpose of this study was to determine the effectiveness of a guided, exploratory learning model for improving students' scientific processing skills and chemistry learning outcomes. This research was conducted at SMA Negeri IPakkat. The sample for this study he consisted of two classes, each of her 35 students, taught directly using guided questions in an experimental and control class. The instruments used were multiple-choice tests (learning outcomes), essay tests (scientific process skills), student worksheets, and observation sheets for the implementation of scientific process skills. The analysis showed that the average gain in learning outcomes for students taught using the guided inquiry learning model (0.78) was significantly higher than the average gain in scientific process skills using the guided inquiry model compared to the direct teaching model (0.66). It turned out that the gains are different. (0.74) as opposed to using the direct statement model (0.65). Two-way t-test hypothesis tests of student learning outcomes and scientific processing skills were scored at 4.397 > 1.995 and 4.980 > 1.995. Thus, we found an impact of the guided inquiry learning model on student learning outcomes and scientific process skills. .*

Keywords: guided inquiry, direct instruction, learning outcomes, scientific process skills

Introduction

The purpose of Indonesian education aimed at human resource development. To achieve these educational goals, the government is trying to improve the quality of education in Indonesia by changing the curriculum over time [1]. The 2013 curriculum is a curriculum that requires students to take an active role in the learning process (student-centered). Teachers act as facilitators or facilitators and learning designers to enable students to actively and creatively explore new knowledge. Learning activities in the 2013 curriculum include observation, questioning, experimentation, association, and communication [2].

Chemistry is a compulsory subject for MIA classes in high school. One of the chemicals in class XI is thermochemistry. Thermochemistry is the study of energy changes in a chemical reaction. Students tend to only calculate problems and use formulations without understanding thermochemistry and connecting these concepts to real life. Most students often forget due to

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memorizing thermochemical material without understanding the concept. This causes the low quality of chemistry learning. One way to improve the quality of learning is to apply guided inquiry learning models and science process skills [3].

Based on the results of interviews with chemistry teachers, the Minimum Completion Threshold (KKM) in Chemistry at SMA Negeri 1PakkatHumbangHasundutan Regency, North Sumatra, Indonesia is 71 students achieving KKM scores in Chemistry, only 45% I know that. Especially for thermochemical materials it is still in the lower category. Also, the learning models used in the teaching and learning process do not actively engage students, making them unmotivated to ask questions or comment on the subject matter of the teacher. The results of the interviews indicated that the use of laboratory equipment and materials was ineffective and the students' skills in the science process were low.

Academic process skills are the development of intellectual, social, and physical skills derived from the student's basic skills. Each student should possess sufficient scientific process skills to enable the student to conduct scientific research. One of the most effective learning models for improving students' scientific process skills is the guided inquiry model [4]. By using a guided inquiry model in chemistry learning, students become active and, under the guidance of their teacher, identify problems, define hypotheses, formulate problems, collect data, verify results, and draw conclusions [5] and [6]. By conducting guided research, students develop scientific understanding and think creatively during their internships, and students become adept at obtaining and analyzing information. Guided, inquiry-based learning gives students more opportunities for direct learning. In addition, because students have the opportunity to practice processes that develop scientific thinking skills, this learning model has the potential to be a solution for improving scientific process skills and learning outcomes for students with direct learning experiences [2], [7], and [8].

The purpose of this study was to determine (1) differences in the improvement of scientific processing skills of students taught through guided inquiry and direct instructional learning models of thermochemical materials and (2) differences in the improvement of learning outcomes. was taught through guided research learning models and direct instruction on the thermochemistry of materials. .

Methodology

This type of research includes experimental studies. The study design uses his two classes, an experimental class and a control class. The study population consisted of 71 all students in class XI of the first semester of SMA Negeri 1Pakkat T.P 2021-2022. Sampling used a targeted sampling technique. That is, XI IPA 2 was used as a control class with a direct instruction model and XI IPA 1 was used as an experimental class with a guided inquiry learning model. A validation instrument was used to measure student learning outcomes and scientific processing skills by giving before and after learning. To test whether a hypothesis is accepted or rejected, the tests used in this study are the two-way t-test and N-gain.

Results and discussions

Result

The learning outcomes analyzed were the experimental and control class gain values obtained from tests performed in two classes after the end of treatment. Statistical data on the improvement

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in students' cognitive learning outcomes in both the experimental and control classes are summarized in Table 1.

Analytical values for scientific process skills are gain values obtained from tests performed after the end of treatment in two classes, a control class and an experimental class. Statistical data on scientific process skill values for control and experimental classes are shown in Table 2.

Students' implementation of scientific process skills is seen and observed by researchers by providing observation sheets during a thermochemistry laboratory course that can be assessed by two observers, including seven indicators of scientific process skills. will be Observe, classify, predict, formulate hypotheses, apply concepts, conclude, communicate. Observations of students' science process skills based on seven indicators of science process skills are shown in Table 3.

Table 1. Student learning outcomes results

Group	Average Value		Deviation Standard	
	Pre-test	Post-test	Pre-test	Post-test
Experimental	32.28	84.85	6.789	6.122
Control	30.86	76.57	6.36	7.15

Table 2. Student Science Process Skill Results

Group	Average Value		Deviation Standard	
	Pre-test	Post-test	Pre-test	Post-test
Experimental	21.14	79.0	6.60	7.10
Control	20.86	71.93	7.81	6.41

Table 3. Percentage of mean values for aspects of skill indicators in the scientific process

Indicator	Experimental Percentage (%)	Control Percentage (%)
Communicate Orally	95%	79%
Grouping	90%	75%
Conclude	89%	71%
Formulating a Hypothesis	90%	78%
Observe	85%	80 %
Interpreting	87%	75%
Applying the Concept	90%	74%

Discussion

In this study, there are two tests to measure student learning outcomes: a pre-learning test and a post-learning test. The following graphs show the learning outcomes of students in the control and experimental classes shown in Figure 1. The starting skills of the two classes before learning are the same. After the student received guided question-based learning in the experimental class, her average score was 84.85 and in the control class she was 76.57. The learning outcome and scientific process skill values analyzed are the return values of the two classes obtained from test results given after completion of treatment from both classes. In Figure 1, we can see that the average increase in learning outcomes for the experimental class is 0.78 (very high), higher than that for the control class, which is 0.66 (high). He then performed a two-way t-test with significance level = 0.05, so the t-value was 4.397 and the t-table was 1.995. .

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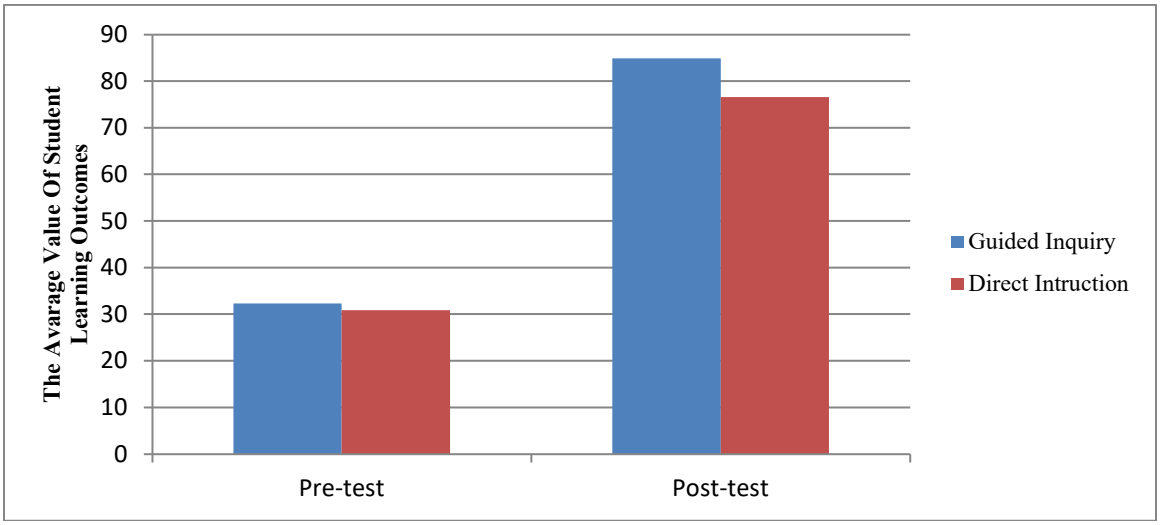


Figure 1. Graph of average student learning outcomes

The guided inquiry learning model can develop student learning methods by direct investigation, so that obtained results can be retained for a long time [9]. The Guided Inquiry model gives students the opportunity to reflect, be proactive, and help each other to share ideas and deepen understanding. This provides good benefits in improving student learning outcomes. This is consistent with a previous study by [10], who found that learning outcomes taught through application of the guided inquiry model increased from pre-test to post-test values. This demonstrates that the guided inquiry model has a significant impact on improving student learning outcomes. From the learning outcome gain data, the average gain for students in the experimental class shows a 78% increase in learning outcome and the control class shows a 66% increase in learning outcome for thermochemical materials.

In this study, there are two tests to obtain the students' science processing ability, a pre-learning test and a post-learning test. The graph below shows the learning outcomes of students in the control and experimental classes shown in Figure 2.

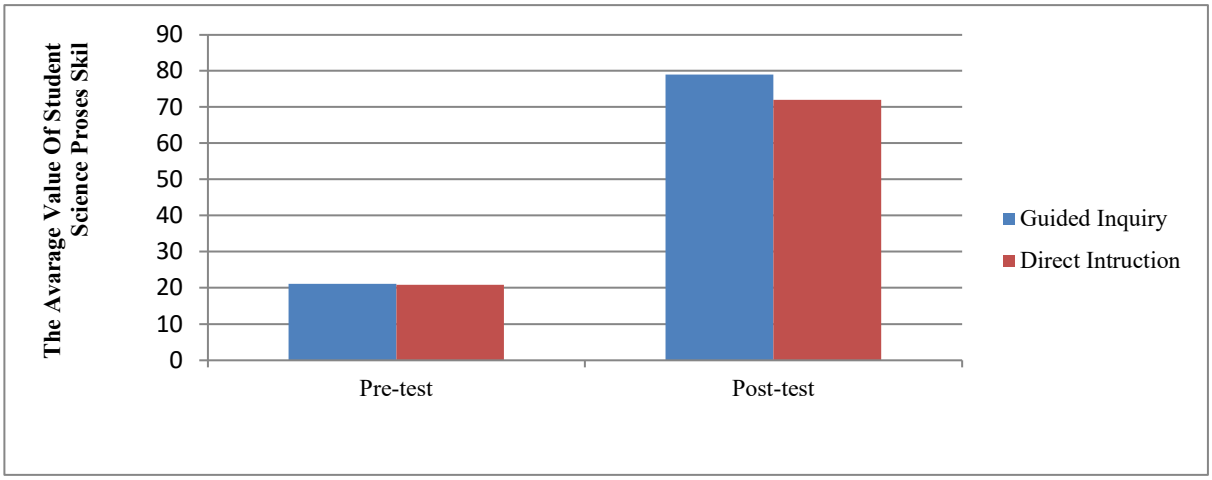


Figure 2. Graph of science process skills

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Figure 2 shows that the guided inquiry learning model influences students' scientific process skills. The average gain for students in the experimental class was 79%, and the average gain for students in the control class was 71.92%, which was higher for students who received the guided inquiry learning model compared to direct instruction in thermochemical materials. It means there is a difference in improving processing skills.

The assessments included in the two sample classes require teacher and student roles for satisfactory results. In the control class, the students listen to the teacher so much that the teacher has to repeat, which makes it difficult for the students to understand. The student's role, taught through guided inquiry, is to conduct real-world problem-solving activities and investigate the issues raised. Teachers guide and direct students when they are confused about the direction of research. This is consistent with previous research that learning using guided inquiry models trains students to develop thinking skills and teamwork, facilitating student learning. In addition, it emphasizes active students, enhances motivational interest, communication, and seeks to master their skills through the process of discovery and problem-solving [11].

This research Conducted in experimental and control classes, each meeting 3 times based on the Lesson Plan (RPP) that had been designed before the research was conducted. At the beginning of the meeting the teacher formed a group consisting of 5 students. Furthermore, the teacher presents a problem situation by conducting demonstrations that confuse students so that it makes students curious and attracts students' attention so as to give students experience in constructing new knowledge, at this stage the teacher also explains procedures to students. By being faced with a situation that is confusing and attracts students' attention, it naturally causes students to be provoked to ask questions related to the teacher's demonstration.

Students are asked or automatically ask questions. Students focus and structure their examinations to solve problems in determining the enthalpy change for a reaction. Then the students asked the teacher to check the truth of the hypothesis by asking questions. In this case the teacher may only respond to student questions with a yes or no answer. Through the questions they asked, they were then instructed to do a "determination of enthalpy change using a calorimeter" practicum with their respective groups to test the hypothesis they had made. Experiments conducted by students aim to train students' science skills. Students conduct experiments by following the student worksheets that have been given. To observe the activities of students' scientific skills, during the experiment the teacher is assisted by the tutor teacher from the school where the research is conducted. After the experiment was completed students were asked to verify the experiment and make conclusions.

A student's implementation of science skills can be observed by a researcher using an observation sheet that can be assessed by two observers. Figure 3 shows the results of observing students' science process skills using indicators.

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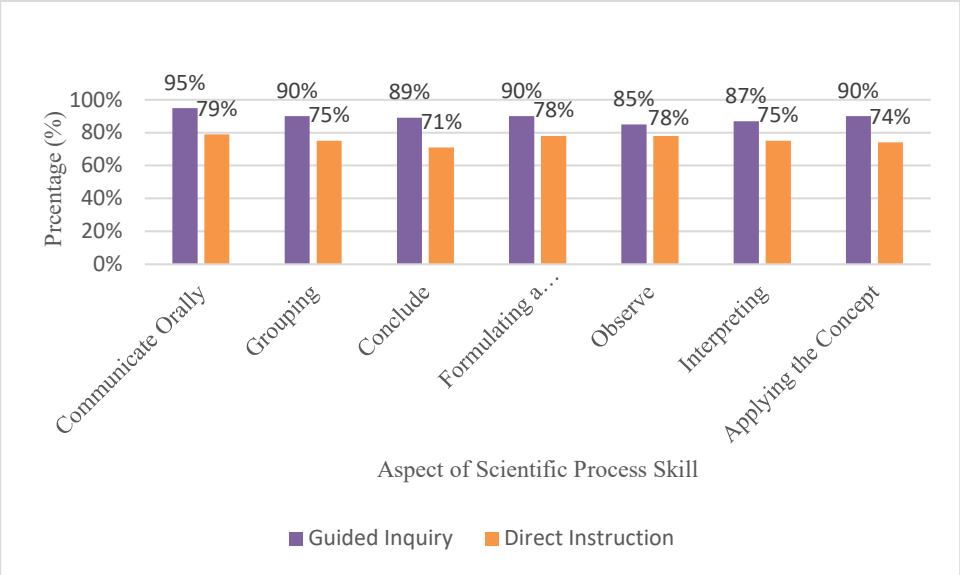


Figure 3. Differences in the percentage of science process skills from the aspect

The Scientific Process Competency Index has seven dimensions, with the lowest score being the Communication dimension at 70%, found in the control class as the direct instruction model is teacher-centered learning. The information center is less student in terms of communicating the results achieved. The highest percentage is the observed index, 95% for the experimental class and 79% for the control class. Experimental teaching shows that the implementation of the guided investigation model in thermochemistry learning meets the 'very good' criteria. This is consistent with looking at his seven dimensions of the Science Process Skills indicator, with the lowest score of 70%, the communication dimension, found in the control class. Acting as an information center, students are less able to communicate their achievements. The highest percentage of observed indices is 95% for the experimental class and 79% for the control class. Data on the implementation of scientific process skills show that there is a "very good" standard for learning with guided inquiry models. This is consistent with research [12] showing that students in experimental classes had higher mean scores for scientific process skills than control classes. Scientific process skills using the Guided Inquiry model can train students to solve problems independently through active participation in laboratory activities. With the guided inquiry learning model, students are more active than with the direct teaching model. Because these two learning models have different syntaxes, the students' learning experience will be different when implementing them.

Based at the statistics analysis, it become observed that the proportion of the implementation of the scientific process when averaged on the guided inquiry model was "very good" because 85 < the percentage of science process skills <100 and the direct instruction model was "good" because 70 < 85. This directly proportional the results of research conducted by [6] on the guided inquiry model there are "very good" criteria in measuring aspects of learning activities, namely learning readiness, skills in using tools, giving opinions, discussing and making conclusions, so that the use of guided inquiry models more successful than using a direct instruction model that meets the "good" criteria in data analysis measuring aspects of learning activities.

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Thermochemistry learning used guided inquiry model is able to provide better qualifications than the direct instruction model, but has not yet reached the maximum. This optimal lack of achievement is influenced by several factors, namely in the learning process there are many deviations that can reduce student interest in learning. In practice, at the beginning of learning students are enthusiastic but after some time they become bored and look less enthusiastic. What the researchers did was to draw back the attention of students by providing illustrations or events in everyday life that are very close to the surrounding environment related to thermochemical material.

Conclusion

After researching, calculating data, and testing hypotheses, the researchers came to the following conclusions.

1. The results of the t-test calculation obtained $t_{count} = 4.397$ and $t_{table} = 1.995$, if $t_{count} > t_{table}$ then the hypothesis Ha is accepted, namely there are differences in the increase in science process skills in students who are taught by guided inquiry and direct instruction models.
2. The results of the t-test calculation obtained $t_{count} = 4.98$ and $t_{table} = 1.995$, if $t_{count} > t_{table}$ then the hypothesis Ha is accepted, namely there are differences in the increase in learning outcomes in students who are taught by guided inquiry and direct instruction models.

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Development of e-module organic chemistry learning case method-based to improve student HOTS

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Abstract. *Due to technological advancements in the digital age, students must possess advanced thinking abilities to successfully navigate the problems of modernization and globalization in the twenty-first century. This study will create case method-based online modules for organic chemistry to enhance student HOTS. The generated e-module complied with the standards and successfully raised student HOTS. The validity of the product is met qualitatively based on the assessment of the media experts and material experts, who are collectively stated in the valid category. The results of statistical hypothesis testing demonstrate that the product's effectiveness has been validated based on the student's performance on the HOTS.*

Keyword: *e-module, organic chemistry learning, case method, HOTS*

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Introduction

The scientific field of chemistry includes a variety of ideas, laws, regulations, norms, and hypotheses [1]. The Universitas Negeri Medan Chemistry Education Study Program is firmly committed to bringing the teaching and learning of chemistry into line with current technological developments and stakeholder needs. This is outlined in the goals of the Chemistry Education Study Program, which include creating superior and qualified graduates in the field of chemistry education, enhancing the caliber of human resources, and enhancing and developing the caliber of the curriculum, teaching methods, and academic environment.

There are significant differences between pre-university education and university education. In addition to courses, themes, and tactical suggestions, the institution provides more. But nonetheless it's also expected to provide a chance for students to learn in a way that encourages the development of their capacity for independent study. Learning independently is making an effort and taking the initiative [2]. However, the main issue with university learning is how to organize and train lecturers to oversee instruction so that students develop the needed competencies [3].

Students are directed to have high-order thinking abilities because they are expected to be able to solve problems creatively and critically (HOTS) [4]. The education offered by HOTS is geared toward educating future generations. The next generation must be equipped with the knowledge and skills necessary for the twenty-first century, including critical thinking, problem-solving, communication, creativity and teamwork [5].

Since the emergence of a global movement asking for new learning models for the 21st century, the idea that formal education must change by introducing new kinds of learning necessary to handle complex global challenges has gained popularity. Instead of curricular content, changes in methodology, such as the switch from simple action to complete the action and from traditional teaching to technology-based education, are under contention [6].

Today's technological advancements in digital technology impact several facets of education, including instructional practices. The quest for more flexible access to time, pace, methodology, and learning efficiency has led to innovative learning techniques leveraging ICT. Students can learn anything, anytime, and anywhere, using ICT, which is a benefit that makes learning easier. However, these present benefits and difficulties for kids regarding independence and a sporadic willingness to learn outside of the classroom. Additionally, the accessibility of complete knowledge necessitates that students choose the best method for processing their crucial lessons. Therefore, as a component of the learning process and product, students must develop independent learning skills [7].

An alternate teaching approach that promotes 21st-century learning and raises student HOTS is the case method. Students will have the chance to introduce other pertinent knowledge domains by the case that occurred prior to the problem analysis by using the case method while learning. Prior knowledge is required for the application of this strategy to the students. The case utilized is a component of a genuine problem scenario and is pertinent to the section of the subject matter covered in learning exercises [8].

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Numerous studies on the case technique have been conducted. The use of the case approach can enhance students' capacity for critical thought and motivation to study [9]. The case method significantly influences students' capacity for critical analysis of reproductive materials [10]. In order to study the chemistry of the topic of solubility and solubility products, the case method application employing audio-visual media is efficiently applied [11]. There is strong evidence that using the case method improves student learning results [12]. Implementing the case method is one of the best approaches that may allow students to develop their creativity, critical thinking, communication, and collaboration abilities (4Cs) [13].

The teaching materials used as learning resources are one aspect that influences students' success in learning in addition to lecturers' usage of learning methodologies. It is impossible to separate the use of instructional materials from assisting in the execution of an efficient learning process. The creation of instructional materials is one strategy that may be used to raise the standard of the educational experience in higher education [14].

The usage of instructional materials that can be used as self-directed learning tools is crucial for the development and improvement of students' higher-order thinking skills. Enclosures for educational products might be printed or plain [15]. Learning can also use non-print based teaching resources, such as electronic teaching resources. The educational industry can utilize information technology networks as a tool for advanced learning, and online learning is not only feasible but can also be implemented [16].

The term "e-module" or "electronic module" refers to one type of electronic instructional resource. An E-Module is a printed module that may be produced using the required software and read by a computer. An e-module is a tool or learning tool that includes content, approaches, constraints, and evaluation techniques that are methodically and beautifully created to accomplish the desired competences in accordance with the difficulty level online. An e-module, which is a presentation of information in book format that is electronically presented via a hard drive, diskette, CD, or flash disk, can be read by a computer or electronic book reader [17].

Given the current phenomena associated with the development of modernization and globalization of the 21st century as well as the rapid development of information and technology, it is necessary to build an organic chemistry learning e-module based on the case method. The development of this case method-based e-module is projected to make organic chemistry instruction simpler for teachers and students while also improving students' HOTS.

The e-module generated in this study was made with the help of the Kvisof Flipbook Creator program or application, which can be used to create e-books, e-modules, e-papers, and e-magazines. This multimedia tool can typically include PDF files, images, movies, and animations to enhance the appeal of the flip book maker. Design templates and functionalities including a background, control buttons, navigation bar, hyperlinks, and return sound are also included in the flip book generator. Students can read by feeling as though they are physically reading a book because there is an animation effect where turning pages will appear as though opening a book. Downloads of the finished product are available as an exe, zipped file, HTML, screen saver, or application [18].

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Methodology

This study, which is underneath the heading of research and development, produced an electronic module for learning organic chemistry based on the case method (R&D). The ADDIE development model, a more generic learning design model, was used since one of its goals is to produce tools and infrastructure for training programs that are effective, dynamic, and supportive of the performance of the training [19]. Analysis, Design, Development, Implementation, and Evaluation are the five steps that make up the ADDIE development methodology.

The process of creating an e-module based on the case method involves several stages, including (a) analysis, which entails gathering data on student needs and reviewing literature pertinent to the product being developed; (b) design, which entails identifying the goals and creating the case method-based e-module; and (c) development, which entails turning the design into a finished product; (d) Implementation, namely implementing the developed product in the form of a case method-based organic chemistry learning e-module; and (e) Evaluation, namely evaluating by analyzing the effectiveness of the case method-based e-module on students' higher order thinking skills (HOTS).

The research methods and tools used in this study include (a) interviews used for data collection as a preliminary study material to look for problems to be studied and used in product trials both at the time of expert validation and product trials in the field as a consideration in improving the developed e-module; (b) the validation sheet used to collect data on the outcomes of the experts' validation of the case method-based e-module designed and to assess its viability or validity; and (c) a test tool created to gather information on student HOTS after HOTS indications spanning C4, C5, and C6.

To assess the viability (validity) and efficacy of the created case method-based e-module, the study data were processed in stages. By taking into account the validator's input, remarks, and recommendations, the data from the experts' validation results were examined. The analysis findings serve as guidance for updating the created instructional materials. The findings of the student's higher-order thinking abilities (HOTS) test were used to determine the success of the designed case method-based e-module. The student's HOTS scores employing a pretest-posttest control group design are used to determine the product's effectiveness. With the aid of the SPSS program, the efficacy test was examined using a t-test or independent sample t-test methodology.

Result and discussion

An electronic learning module for organic chemistry using the case method is the end result of this work. The Kvisof Flipbook Maker application was used to compile and develop the e-module. Validators who are experts in their field evaluate the validity or viability of case method-based e-modules. Students can assess the efficacy of the developed goods by using those that were created and found to be feasible.

Product validity

Based on the viability of the content and the viability of the media, expert validators constructed, examined, and assessed the validity (feasibility) of the case method-based Organic Chemistry learning e-module.

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An evaluation by a material expert validator and a media expert of the case method-based organic chemistry learning e-module that was produced is depicted in Table 1. The expert validation of the material's findings was awarded an overall average score of 4.33 and was accepted as valid. The average score for the media expert validation's findings was 4.29, and as a result, they were approved. Overall, the evaluation of media and material specialists by the validator led to the conclusion that the case method-based organic chemistry learning e-module that was created had met the valid requirements, making it possible to move forward with the implementation stage.

Table 1. Validation results on material and media aspects

Validator	No.	Aspects of assessment	Mean Score	Criteria
Theory	1	Content feasibility	4.31	Valid
	2	Serving feasibility	4.27	Valid
	3	Language feasibility	4.41	Valid
	4	Characteristics of e-module	4.25	Valid
	5	Case method	4.40	Valid
		Total Mean	4.33	Valid
Media	1	Software	4.20	Valid
	2	Interface view	4.19	Valid
	3	Visual communication	4.33	Valid
	4	Consistency	4.42	Valid
		Total Mean	4.29	Valid

Student HOTS achievements

After deploying the case method-based organic chemistry learning e-module, formative evaluation was used to determine the student HOTS achievements. Two sample groups were used in the product's implementation: the experimental group, which used the case method-based organic chemistry learning e-module, and the control group for comparison (without the case method-based organic chemistry learning e-module).

Table 2. Student HOTS achievements

Class	N	Minimum	Maximum	Mean	S. Deviation	K-S Test	Sig
Experiment	30	74	96	85.07	5.058	0.584	0.885
Control	30	76	90	81.33	3.336	0.668	0.763

The achievement of the HOTS test results for the two sample groups is displayed in Table 2. The experimental group's average student HOTS score was 85.07±5.058 after using the case method-based organic chemistry learning e-module. The data were distributed normally, and the

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Kolmogorov-Smirnov test result was 0.584, with a p value of 0.885. The average student HOTS score for the control group, which consisted of students who did not use the case method-based organic chemistry learning e-module, was 81.33±3.336. The data had a normal distribution, a Kolmogorov-Smirnov test value of 0.668, and a p value of 0.763.

Product effectiveness

The effectiveness of the case method-based organic chemistry learning e-module was evaluated using a pretest-posttest control group approach to assess student learning outcomes in passing the HOTS test. The efficiency was evaluated with the aid of the SPSS computer utilizing a t-test or an independent sample t-test methodology.

According to Table 3's analysis of the t-test results using the independent sample t-test method, the average difference or difference in the HOTS scores of students in the two sample groups is 3.733±1.106. The t-value is 3.375 with a probability or Sig. of 0.001 < 0.05. It was determined that the implementation of the developed case method-based organic chemistry learning e-module was successful in raising student HOTS (without e-module case method-based organic chemistry learning module) in light of the fact that experimental class students who used the case method-based organic chemistry learning e-module had higher average HOTS than control class students.

Table 3. T-test results (independent sample t-test)

	t	df	Sig	Mean Difference	Std. Error Difference
Equal variances assumed	3.375	58	0.001	3.733	1.106

Conclusion

This research and development produced the Case Method-based Organic Chemistry learning e-module using the ADDIE development approach. It has been demonstrated that the Case Method-based Organic Chemistry Learning E-Module improves student HOTS and satisfies legal criteria. The validity is qualitatively met based on the assessment of the material's and media experts' validators, as generally indicated in the valid category. Effectiveness is demonstrated by the use of the Case Method-based Organic Chemistry Learning E-Module and the results of statistical hypothesis testing. The experimental class student group that applied to it earned a higher average HOTS score than the control class student group that did not use the Case Method-based Organic Chemistry learning e-module. It is necessary to do continual research and development in the form of case method-based e-modules supported by digital technology in order to improve students' HOTS skills in other chemistry courses.

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Development of e-learning physical chemistry CBT integrated to improve students' chemical literacy

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Abstract. *21st century learning is required to be technology-based to balance the demands of the millennial era with the aim that later students will become familiar with 21st century life skills. This study aims to develop CBT integrated physical chemistry e-learning to improve students' chemical literacy skills. The resulting CBT integrated e-learning has met the valid criteria and has been proven to be effective in improving students' chemical literacy skills. The increase in students' chemical literacy skills is evidenced by the increase in the achievement of test results before and after using integrated e-learning (CBT) which is produced by the average value of the pretest-posttest difference or an increase in students' chemical literacy skills of 36.80±8.364.*

Keyword: integrated e-learning, chemical literacy

Introduction

Science education has an important role in preparing quality human resources in the face of globalization. The potential of science education can be seen from the ability to communicate,

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critical thinking, problem solving, mastery of technology and the ability to adapt to changes and times. The process and learning of science can produce quality human beings by showing scientific awareness (scientific literacy) and higher-order thinking skills that can create human resources capable of critical thinking, creative thinking, decision making and problem solving [1].

Trends in science education policy in the 21st century emphasize the importance of scientific literacy as a transferable outcome [2]. In the 21st century, literacy skills are not only limited to the ability to read, listen, write and speak orally, but more than that, literacy skills are emphasized on literacy skills that are connected to one another in the current digital era [3].

Scientific literacy is defined as the ability to use scientific knowledge, identify questions and draw fact-based conclusions to understand the universe and make decisions about changes that occur due to human activities [1]. Indonesian language literacy skills are included in the low category based on the 2015 Program for International Student Assessment (PISA) study report. For scientific literacy, Indonesian students are ranked 62 out of 70 countries with a score of 403, for mathematical literacy, Indonesian students are ranked 63 out of 70. countries with a score of 386 even for reading literacy are ranked 64 out of 70 countries with a score of 397 [1]. The results of these achievements indicate that the average scientific literacy ability in Indonesia is only able to recognize basic facts, but has not been able to communicate and relate these abilities to various scientific topics, especially to apply concepts in life.

Scientific literacy is one of the parameters in determining the human development index which is strongly influenced by the quality of education. The development of scientific literacy skills is not only influenced by the learning model but also the textbooks used. However, the science textbooks used today do not contain a balanced component of scientific literacy [1]. Chemistry is included in the scientific family, so chemical literacy is part of scientific literacy. Chemistry is a branch of natural science that includes concepts, rules, laws, principles, and theories [4]. Chemical literacy is related to how students can appreciate nature by utilizing the science/chemistry and technology they master. People who have chemical literacy understand the basic concepts of chemistry, can explain phenomena and solve problems in life using their understanding of chemistry, understand chemical innovations in social life and have an interest in chemistry [5].

The development of digital technology affects various aspects of education including learning strategies. The need for more flexible access to time, speed, methods and efficiency in learning creates innovative learning strategies that involve ICT. ICT-supported learning allows students to learn anything, anytime and anywhere is an advantage that facilitates the learning process. These advantages, on the other hand, pose challenges for students regarding the character of independence and a spontaneous desire to learn outside the classroom. Moreover, the availability of unlimited information requires students to determine the right strategy to be able to process their learning which is very important. Therefore, students need to develop independent learning skills as part of the learning process and output [6].

The scientific literacy (chemistry) ability of each student is certainly different, depending on the exercises that are often done to develop it. E-learning is a distance learning model that plays a big role in the world of education [7]. The term E-Learning is learning delivered using a computer via a CD-ROM, internet or intranet. E-learning or online is learning that uses learning resources through technology and other media [8]. E-learning has four characteristics, namely: a) utilizing electronic technology services; b) take advantage of the advantages of computers; c) using independent teaching materials; and e) using computers to store learning schedules, learning

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outcomes and matters relating to learning administration [9]. In addition to characteristics, e-learning also has benefits as a supplement, as a complement and as a substitute.

E-learning is an option and solution for implementing learning in the digital era by utilizing the internet network. Learning using E-Learning requires students to be more independent in learning, thus learning with e-learning can increase student activities. Learning with e-learning can also guide students to learn independently so that learning can shift from teacher-oriented learning (teacher centered), to student oriented learning (student centered*)* [10].

In addition to the ability to develop the learning process, an educator, both teachers and lecturers, is required to have the ability to evaluate and assess student learning outcomes. The ability of educators in mastering evaluation techniques is indicated by their ability to design evaluation patterns, develop instruments, set goals, see the results obtained by students, and choose appropriate actions as an effort to follow up on evaluation and assessment results. Therefore, an educator, both teachers and lecturers, must be able to make the right evaluation media, because the evaluation media is very influential in increasing students' understanding and learning achievement. On the other hand, if the evaluation media is not appropriate, there will be errors in measuring learning outcomes and students' understanding.

The 21st century, with the rapid development of information and technology, also demands changes and adjustments in evaluation activities which generally use paper and pencil based tests (PBT) which are now turning to computer based tests (CBT), namely evaluation or assessment activities using computer media and based online. managed by server [11]. CBT is a test used to measure learning achievement using a computer [12], through internet access with the assessment carried out automatically by the computer [13], don't need paper, pen or pencil to answer every question [14], Student responses to tests can be stored and analyzed electronically and widely used [15].

The shift from paper-based learning evaluation to computers in order to reduce the weaknesses of paper-based learning evaluation, and to realize paperless in the current digital era must be done. This is because CBT has several advantages including being more time efficient in doing it, students do not need to use paper or pens, just sit quietly and answer the questions available on the computer [12], it is allowed to take the test at the right time for the participants, reduce the time for test assessment work and make written reports, eliminate logistical work such as distributing and storing tests using paper, test takers can immediately know the results [16]. CBT is also very helpful for educators in conducting diagnostic tests. It is easier for educators to prepare, process, and make academic policies for students [17].

Seeing the existing phenomena related to the development of modernization and globalization of the 21st century, the rapid development of information and technology, it is necessary to develop e-learning in CBT integrated Physical Chemistry learning which is expected to support the implementation of an effective and efficient learning process. The development of CBT integrated e-learning is expected to facilitate lecturers and students in the learning process of Physical Chemistry and is expected to assist lecturers in conducting diagnostic tests and in making academic policies for students.

Methodology

This research belongs to the type of research and development (R&D), and the result of this development research is e-learning physical chemistry CBT integrated. The development model

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used refers to the ADDIE development model which is a more generic learning design model, namely as one of its functions to build tools and infrastructure for training programs that are effective, dynamic and support the performance of the training itself [18]. The ADDIE development model uses 5 stages as the name implies, namely: Analysis, Design, Development, Implementation, and Evaluation. The subjects in this study were 30 students of Chemistry Education Study Program.

The procedure for developing an e-module based on the case method is carried out through several stages, including: (a) Analysis, namely conducting an analysis to collect information related to student needs and reviewing literature related to the product being developed; (b) Design, which is the stage carried out to identify goals and create an integrated CBT e-learning design that will be developed; (c) Development, is the stage to realize the design into a product that is ready to be implemented; (d) Implementation, namely implementing the developed product in the form of integrated CBT Physical Chemistry e-learning; and (e) Evaluation, namely evaluating by analyzing the effectiveness of CBT integrated e-learning on students' chemical literacy skills.

The techniques and instruments used in this study include (a) interviews used for data collection when conducting research as a preliminary study material to look for problems to be studied and used in product trials both at the time of validation to experts and product trials in the field as consideration in improving the developed e-learning and CBT; (b) validation sheet used to obtain data on the results of expert validation on e-learning and CBT developed and test their feasibility or validity; and (c) a test instrument designed to obtain data on students' chemical literacy skills in physical chemistry.

The research data was analyzed in stages to determine the feasibility (validity) and effectiveness of the developed e-learning CBT integrated. The data from the validation results of the experts were analyzed by considering the input, comments, and suggestions from the validator. The results of the analysis are used as guidelines for revising the products developed. The effectiveness of the developed e-learning CBT integrated is obtained from the results of the student's chemical literacy ability test. The effectiveness of the product is obtained from the achievement of students' chemical literacy ability test results using the t-test or paired sample t-test approach with the help of the SPSS program.

Result and discussion

The product developed in this study is an e-learning CBT integrated physical chemistry. E-learning CBT integrated was developed with the aim of facilitating lecturers and students in the Physical Chemistry learning process and is expected to assist lecturers in conducting diagnostic tests and in making academic policies for students. Validation or feasibility of e-learning CBT integrated is evaluated by expert validators in their field. The products produced and have been declared feasible by expert validators are then implemented for students to analyze the effectiveness of the products produced.

Product validity

The validity (feasibility) of the e-learning Physical Chemistry CBT integrated developed, evaluated and assessed by expert validators based on the feasibility of the material and the feasibility of the media.

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Table 1 shows the results of the material expert validator's assessment of the e-learning physical chemistry CBT integrated developed. The results of expert validation on the material on the e-learning component obtained an average total score of 4.28 (valid) and on the CBT component, the average total score was 4.38 (valid). Thus, overall the results of the material expert validator's assessment concluded that the CBT integrated physical chemistry e-learning developed had met the valid criteria so that it was feasible to continue at the implementation stage.

Table 1. The results of the validation of the e-learning CBT integrated on the material aspect

Component	No.	Assessment Aspect	Mean Score	Criteria
E-Learning	1	Content feasibility	4.25	Valid
	2	Serving feasibility	4.30	Valid
	3	Language feasibility	4.33	Valid
	4	Graphic feasibility	4.25	Valid
		Total Mean	4.28	Valid
CBT	1	Content (material)	4.50	Valid
	2	Construct	4.00	Valid
	3	Language	4.67	Valid
	4	Time and hint	4.33	Valid
		Total Mean	4.38	Valid

Table 2. The results of the validation of the e-learning CBT integrated on the media aspect

Komponen	No.	Assessment Aspect	Mean Score	Criteria
E-Learning	1	Software engineering	4.33	Valid
	2	Interface view	4.38	Valid
	3	Verbal communication	4.22	Valid
		Total Mean	4.31	Valid
CBT	1	Software engineering	4.00	Valid
	2	Interface view	4.44	Valid
	3	Verbal communication	4.13	Valid
		Total Mean	4.19	Valid

Table 2, shows the results of the media expert validator's assessment on the developed e-learning physical chemistry CBT integrated. The results of expert validation on the media on the e-learning component obtained an average total score of 4.31 (valid) and on the CBT component, the average total score was 4.19 (valid). Thus, overall the results of the media expert validator's assessment concluded that the CBT integrated physical chemistry e-learning developed had met the valid criteria so that it was feasible to continue at the implementation stage.

Achievement of student chemistry literacy ability

The achievement of students' chemical literacy skills is obtained through formative evaluation after implementing the e-learning physical chemistry CBT integrated.

Table 3. Achievement of student chemistry literacy ability

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Data	N	Minimum	Maximum	Mean	S. Deviation	K-S Test	Sig
Pretest	30	40	56	46.47	4.747	0.721	0.676
Posttest	30	74	92	83.27	4.712	1.037	0.233

Table 3, showing the achievement of students' chemical literacy test results before the pretest was carried out, the average value was 46.47±4.747 and the data had a normal distribution with the Kolmogorov-Smirnov test value of 0.721 and sig. of 0.676. After learning with the implementation of the e-learning physical chemistry CBT-integrated (posttest) the average value was 83.27±4.712 and the data had a normal distribution with the Kolmogorov-Smirnov test value of 1,037 with sig. of 0.233.

Product effectiveness

The effectiveness of the e-learning physical chemistry CBT integrated developed was analyzed from the results of the students' chemical literacy skills. The effectiveness was analyzed using a t-test or a paired sample t-test approach with the help of the SPSS program.

Table 4. T-test results (paired sample t-test)

		Paired Differences		*t*	*df*	*Sig. (2-tailed)*
		Mean	*Std. Deviation*			
Pair 1	Posttest – pretest	36,800	8,364	24,098	29	0,000

Table 4, shows the results of the t-test with an independent sample t-test approach and the average difference or difference in the HOTS scores of students in the two sample groups is 3.733±1.106 and the t-value is 3.375 with probability or Sig. of 0.001 < 0.05. Thus, it was concluded that the implementation of the case method-based organic chemistry learning e-module that was developed proved effective in increasing student HOTS where the average HOTS of experimental class students who applied the case method-based organic chemistry learning e-module was higher than control class students (without e-module case method-based organic chemistry learning module).

Table 4, shows the results of testing the effectiveness of the e-learning Physical Chemistry CBT integrated and obtained a t-value of 24,098 with probability or Sig. of 0.000 < 0.05 so that it can be concluded that the implementation of the resulting e-learning Physical Chemistry CBT integrated has proven to be effective in improving students' chemical literacy skills with an average score difference (posttest-pretest) of 36.80±8.364.

Conclusion

This research and development resulted in e-learning Physical Chemistry CBT integrated through the ADDIE development model. The resulting e-learning Physical Chemistry CBT integrated has met the valid criteria and has been proven to be effective in improving students' chemical literacy skills. The validity is met qualitatively based on the assessment of the validators of material experts and media experts which are overall stated in the valid category. The effectiveness is fulfilled based on the implementation of e-learning CBT integrated in student learning activities as well as

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proven from the results of statistical hypothesis testing. The increase in students' chemical literacy skills is evidenced by the increase in the achievement of test results before and after using the resulting e-learning CBT integrated. The average value of the difference between the pretest-posttest or the increase in students' chemical literacy skills was 36.80±8.364. Thus, it is necessary to carry out continuous research and development in the form of e-learning CBT integrated supported by digital technology in improving students' chemical literacy skills in other chemistry lessons in the future.

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Mapping risk zones of Covid 19 diseases in north sumatera based on geographic information system with codeigniter

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Abstract. *The Covid-19 pandemic has shaken the entire community. The COVID-19 pandemic has had a significant social impact. To restrict the spread of Covid-19, ongoing efforts are required. It is critical to understand which locations remain sensitive to the COVID-19 sickness. Information about the development of Covid-19 can be accessed through the website provided by the North Sumatra Health Office. However, information on the risk zones denoted by colour is not yet available on the North Sumatra Health Service website. This research attempts to design and implement a system as a response to the community's difficulties caused by the covid-19 pandemic. The methods used are observational studies, data collection and questionnaires. The Waterfall development paradigm was employed in this study to create devices. Colour is determined by clustering using the K-means algorithm. The results of the study indicate that the results of the system development that have been carried out can be drawn several conclusions that this research resulted in a Geographic information system (GIS) on maps of the distribution and status of the covid-19 zone. Geographic Information System (GIS) is easily accessible by users simply by using a web browser. With the GIS-COV website, it can help the public to see and know the risk zones for cases and the status of the spread of COVID-19. With the GIS website, the public can find out the number of Covid-19 spreads, the number that has been swapped, vaccination information from each dose and certain zones with the highest and lowest levels of spread.*

Keywords: GIS, Covid 19, north sumatera, risk zone, codeigniter.

Introduction

Coronavirus disease 2019 (COVID-19) is defined as a disease caused by a new strain of coronavirus, which belongs to a large family of viruses such as Middle East Respiratory Syndrome (MERS-CoV). In Indonesia, from 3 January 2020 to 4:36pm to 4 November 2022, there have been 6,512,913 confirmed cases of COVID-19 with 158,768 deaths, reported to WHO and a total of 439,654,699 vaccine doses have been administered [1]. Based on the latest data on Saturday (5/10/2022) form Kompas.com, the number of cases nationally has continued to

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increase since the first patient case infected with the corona virus was announced on March 2, 2020. The number of positive cases confirmed based on examination using the polymerase chain reaction (PCR) method as follows: Positive numbered 160678 Recovered totaled 15843, and Died amounted to 3312 [2].

Geographic Information System (GIS) plays a wide range of roles and can be used to a wide range of natural phenomena. Not only is there a problem with city planning, location, and regional planning, but there is also a problem with mapping the distribution of diseases caused by viral infections, such as COVID-19 (corona virus diseases 2019), an epidemic that has devastated several countries, including Indonesia, particularly the North Sumatera Province. A Geographic Information System (GIS) is a type of information system that uses spatially differentiated graphic data or geographic coordinates to get regional/location information, such as digital maps. The COVID-19 distribution map can be displayed more interactively, effectively, and informatively, as well as an educational element, using this GIS web-based technology, and it is hoped that it will provide the information needed by the public, causing them to be more concerned about the dangers of COVID-19 and to always apply health protocols in his daily life [1]. Important components of Geographic Information Systems include: (1) hardware (computers) for data storage and processing; (2) software that can be used, such as ArcView, ArcGis, and QuantumGis; and (3) data in the form of spatial (points, lines, and polygons) and non-spatial data (in the form of information owned by objects in spatial data). Some researches built and developed GIS in several ways and views. Mardalius (2020) built GIS used several supporting softwares. Codeigniter Framework with MVC (Model, View, Controller) model to build dynamic websites using PHP, in this article there are Router, File Chache, Security. Next, he used LeafletJS to finalize the GIS. The LeafletJS allows anyone without a GIS background to easily display tiled web maps on public servers. The Web APIs that used the POSIX standard, and applications compiled to work on certain operating systems can also work on other systems that have the same criteria. Data was used to display the number of infected data is taken from the API website https://kawalcorona.com/. Next researcher, Das & Bebortta (2022) designed framework as below

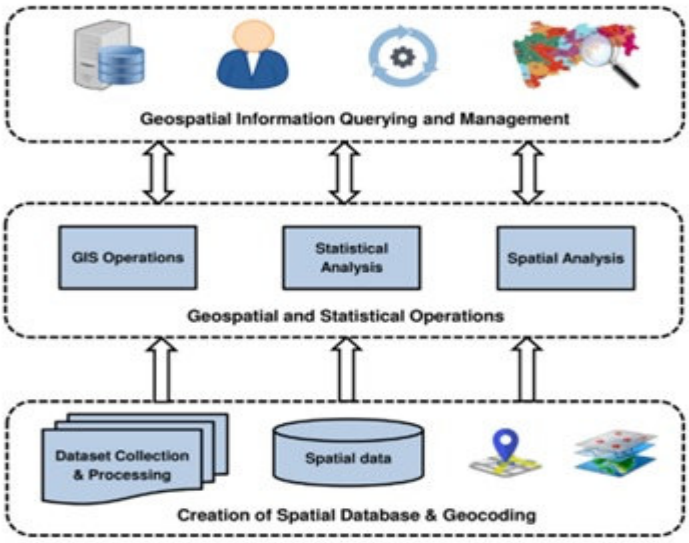


Figure 1. A three-tiered proposed structure for geospatial processing and visualization.

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The data is converted into a spatial database by performing geocoding operations that allocate latitude and longitude values. Data is imported as text into a GIS application and Visualized by various choropleth maps representing cases in COVID 19. Each feature attribute is plotted as data point over Maharashtra province vector shape file. They proposed framework is a collection of geocoded data entered into a spatial database and a point-vector overlay operation with creating labels for each district. The last, Landicho in 2018 designed and developed a program application that could provide information about the road projects in a more detailed and informative way and can be easily accessed by the public. The following is architecture web as Figure 2 showed client layer based on yahoo map and API was obtained from google APIs.

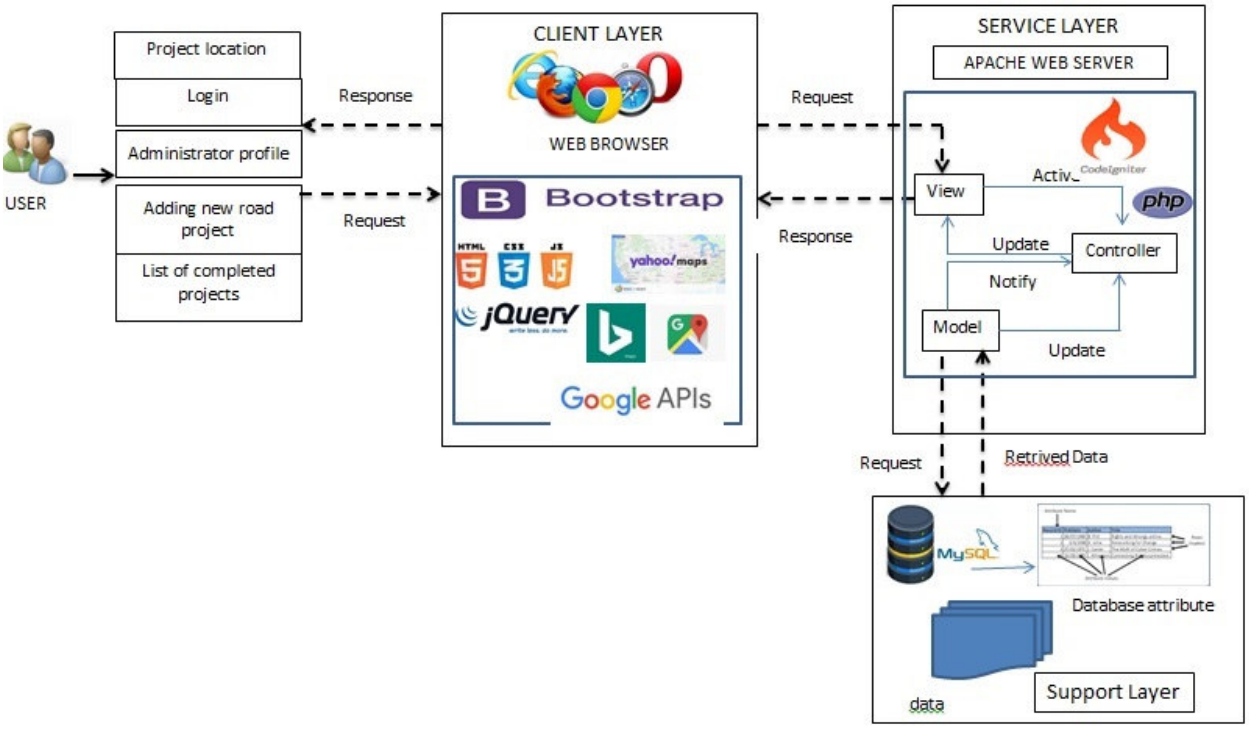


Figure 2. Architecture web

We examined similar work assessing the impact of COVID-19 using a variety of technologies in the computer science domain. We present a common GIS-based framework that requires three modules to generate various maps to visualize COVID-19 risk zones in a given area. This distribution might define or provide information on the amount of exposure in each sub-district in North Sumatera Province that is exposed to Covid-19 in this map of the spread of Covid-19. Vulnerability levels can be classified into five categories (very high, high, medium, low, and very low), three categories (high, moderate, and low), or two categories (high, moderate, and low) (high and low).

This article considers the Fuzzy C-means clustering approach as a technique for clustering data on confirmed, recovered, died and second vaccine outcomes. so that later the use of flask software to integrate between the cluster that is run in python and the map that will be built in codeigniter. Several analyzes will be discussed from the development of COVID-19 cases,

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vaccines and vaccine targets, the number of ICU patients and the isolation of COVID-19 patients, specimen actions against patients.

Methodology

A web server is required to communicate with many devices in the web environment. Because geodata standards differ and are highly particular, the system architecture development follows the 'Client Server' architecture. The system design is based on the designed architecture. Architectural design describes the performance of the system as a whole when there are activities carried out by users. This system is web-based and uses the CodeIgniter framework. The architectural design consists of 3 layers where each layer has its own components and tasks, namely the client layer, service layer, and support layer. The following is the architectural design of the system shown in Figure 3.

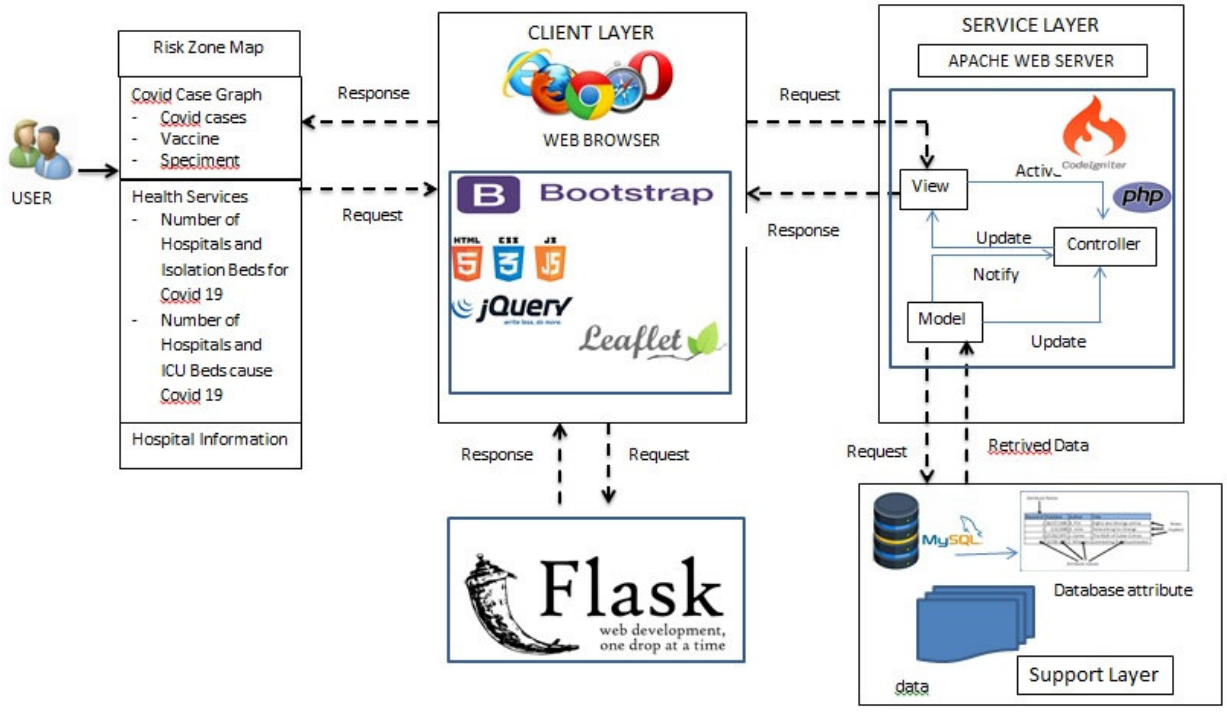


Figure 3. Architecture of GIS system

Figure 3 depicts the bare bones of a Web GIS system. On the client side, the application communicates with the server as a data provider using web protocols such as HTTP (Hyper Text Transfer Protocol). On the server side, GIS is responsible for connecting to spatial databases, such as translating queries into SQL and creating representations that are forwarded to the server.

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Database

The following is an implementation of the database design used in the system

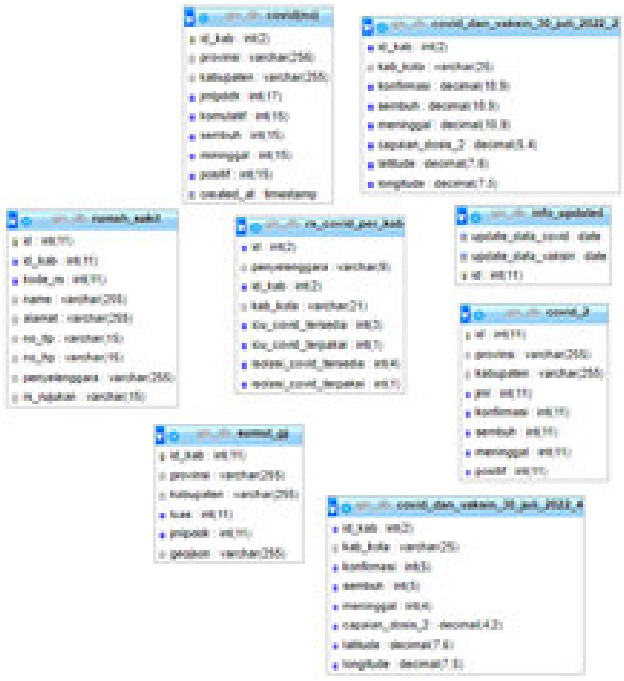


Figure 4. Database

Rest API

REST (Representational State Transfer) is an architectural method of communication that uses the HTTP protocol for data exchange and this method is often applied in application development. This data shows the total spread of COVID-19 as a whole, namely total confirmation, total recovery, total death, and vaccine achievement. This data is initially in the form of JSON format, which will retrieve the attributes in it and display them on the created website.

Stages of Deploy Fuzzy C-Means Clustering Model. This stage aims to deploy the model by turning it into an API using a framework called Flask. An API or web service developed with flask will contain a pre-built Fuzzy C-Means model. In main.py, the Fuzzy C-Means model that has been developed previously will be run. The contents of the script can be seen as follows.

Script 1. Source code running fuzzy C-Means in flask

```
from flask import Flask, request
import pandas as pd
import numpy as np
from flask_cors import CORS

# Z-Scoree
import scipy.stats as stats
```

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```
# K Means
from sklearn.cluster import KMeans
# Fuzzy C Means
from fcmeans import FCM

app = Flask(__name__)
CORS(app, resources={r"*": {"origins": "*"}})

@app.route("/")
def hello_world():
    return "<p>API Running Well</p>"

@app.route('/kmeans', methods=['POST'])
def kmeans():
    dataReq = request.json
    dataFrame = pd.DataFrame(dataReq['data'])
    # data preprocessing
    dataFrame1 = dataFrame.iloc[:,2:8].copy()
    print(dataFrame1)
    dataFrame1 = dataFrame1.astype(float)

    # data normalisasi (zscore)
    dataFrame1 = stats.zscore(dataFrame1)
    # Kmeans
    kmeans = KMeans(n_clusters=dataReq['n_cluster'], init='k-means++', random_state=42)
    y_kmeans = kmeans.fit_predict(dataFrame1)

    dataFrame = dataFrame.assign(cluster=y_kmeans)

    result = dataFrame.to_json(orient="records")
    return result

@app.route('/fuzzy_c_means', methods=['POST'])
def fuzzycmeans():
    dataReq = request.json
    dataFrame = pd.DataFrame(dataReq['data'])
    # data preprocessing
    dataFrame1 = dataFrame.iloc[:,2:8].copy()
    dataFrame1 = dataFrame1.astype(float)

    # data normalisasi (zscore)
    dataFrame1 = stats.zscore(dataFrame1)

    fcm = FCM(n_clusters=dataReq['n_cluster'])
    fcm.fit(dataFrame1.values)

    # outputs
    y_fuzzycmeans = fcm.predict(dataFrame1.values)

    dataFrame = dataFrame.assign(cluster=y_fuzzycmeans)
```

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```
result = dataFrame.to_json(orient="records")
return result
```

After running, then access the endpoint or with the POST method on API testing applications such as Insomnia. Up to this point, the web service can be accessed only locally, but when the terminal is not started, the web service will not be accessible again. Therefore, the next step is to deploy a web service on one of the free services from Heroku (see Figure 6). To make it easier to access and integrate into the GIS website that has been built. The following is a visualization of insomnia for the endpoint test.

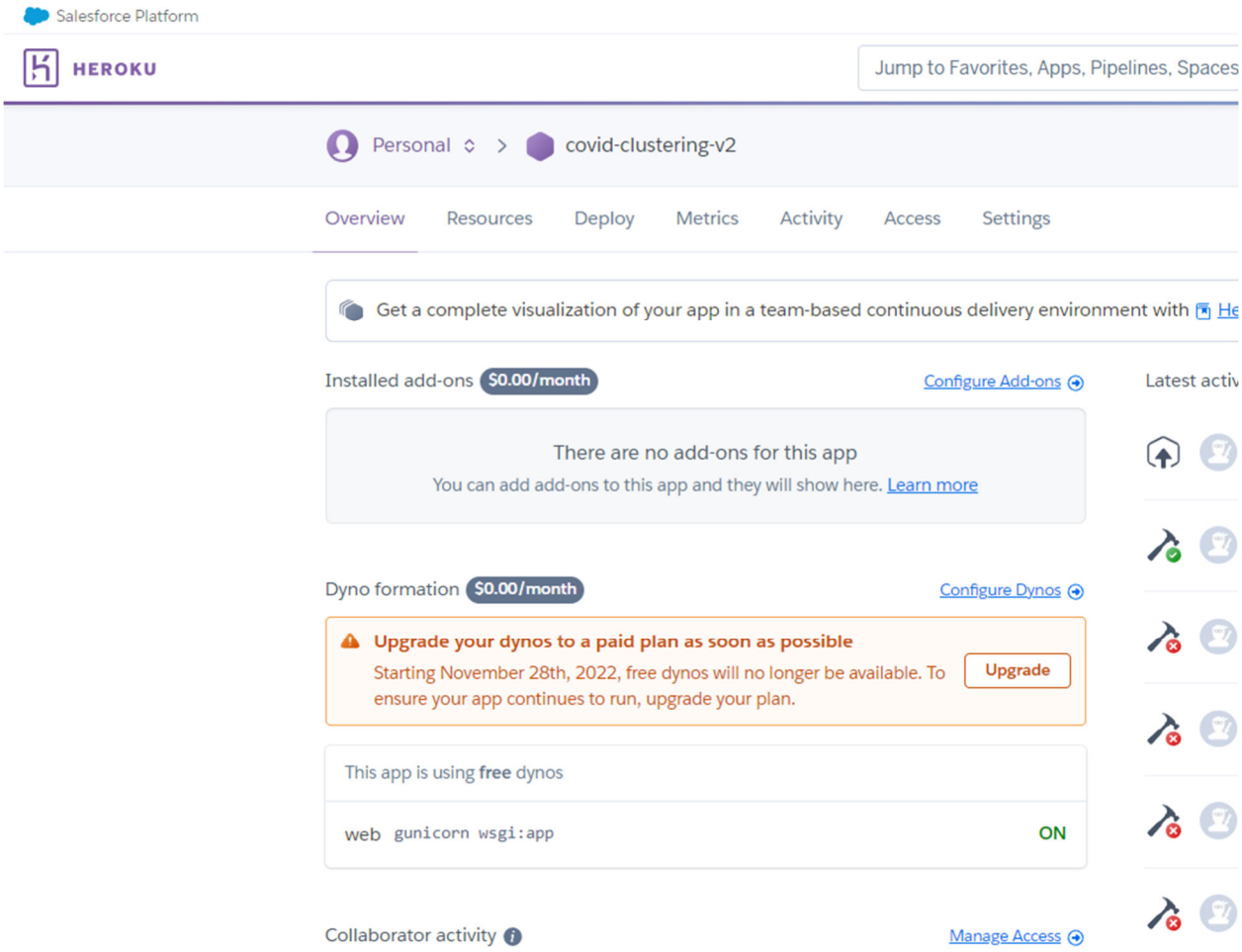


Figure 5. Heroku

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The API data can be seen in the Figure 6.


```
[
  {
    "id_kab": 1,
    "kab_kota": "Kota Tebing Tinggi",
    "konfirmasi": 1968,
    "sembuh": 1924,
    "meninggal": 42,
    "capaian_dosis_2": 65.94,
    "latitude": 3.385621,
    "longitude": 99.20098,
    "cluster": 0
  },
```


Figure 6. API data

Leaflet is an open source JavaScript library for building mobile friendly interactive maps. In LeafletJS there are lots of features to visualize map data in the form of a website. Leaflet enables anyone with no prior knowledge of GIS (geographic Information System) to simply display online maps on public servers. There are numerous plugins that can be used to enhance the webmap's functionality. In this case, the mapping of COVID-19 in North Sumatra Province will be shown based on district boundaries.



Figure 7. Leaflet logo

Result and discussion

The User Interface (UI) design is designed with several aspects ranging from layout, logo images, appropriate color selection, and other things that aim to make WebGIS look eye-catching for stakeholders. GIS Web-Based Covid-19 Spread Mapping can be accessed quickly, easily and informatively regarding the development of Covid-19 cases in the North Sumatra Province. The map on the system is able to display information in each district in the form of the number of confirmed, recovered, died and vaccine achievements. The coloring on the map goes through a clustering process using the Fuzzy C Means method with two clusters. The system that was built not only displays the division of zones but also graphs of case development, vaccine achievements and targets, specimen info as well as the Number of Hospitals and ICU Beds for Covid 19 and Number of Hospitals and Covid 19 Isolation Beds per Regency.

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This study uses data from the covid-19 province of North Sumatra, which comprises of 33 regencies. The data used in this study was obtained between March 2020 and September 2022, and it includes Confirmed, Recovered, Died, and the completion of the second dose of vaccine. The main data is shown in Table 1.

Table 1. The main data

No	Regencies/ City	Confirmation	Recovered	Death	Vaccine Achievements	Latitude	Longitude
1	Tebing Tinggi	2001	1957	42	64.69874	3.385621	99.20098
2	Dairi	3395	3284	105	69.58	2.198851	98.5721
3	Pakpak Bharat	392	382	10	72.44179	2.040525	99.10135
4	Padang Lawas Utara	340	326	14	64.36829	2.978161	99.27856
5	Binjai	3082	2997	80	66.17485	-8.17126	113.7111
6	Deli Serdang	24386	23839	498	57.32052	2.86758	98.26506
7	Tanjung Balai	869	824	42	59.94989	2.545786	98.29984
8	Medan	75720	74529	1027	69.97296	2.35024	99.27856
9	Labuhan Batu Selatan	1187	1155	31	58.54267	1.575864	99.63414
10	Karo	2812	2770	40	73.57666	0.743237	99.36731
11	Padangsidimpuan	1518	1467	49	59.6335	3.42018	98.70408
12	Padang Lawas	517	481	31	64.21798	2.965122	99.80033
13	Pematang Siantar	6269	6145	107	73.87103	1.84933	98.70408
14	Gunung Sitoli	1571	1546	25	69.14062	3.337169	99.05711
15	Nias Barat	206	205	1	57.24159	3.585242	98.6756
16	Sibolga	939	907	31	81.64962	1.440806	97.47059
17	Nias Selatan	325	321	0	60.83138	1.983	100.0976
18	Langkat	3244	3112	126	59.84001	3.105291	98.26506
19	Batubara	2368	2279	83	64.67135	1.380424	99.27397
20	Samosir	2554	2510	44	80.16432	2.343986	100.1703
21	Humbang Hasundutan	868	832	30	74.82541	2.817472	99.63414
22	Tapanuli Utara	2574	2535	36	73.09997	2.41667	99.75
23	Simalungun	5229	4974	234	58.03972	1.118698	99.81249
24	Nias	410	406	4	61.67435	2.96	99.06
25	Mandailing Natal	764	732	32	59.14702	1.3273	97.5502
26	Tapanuli Tengah	1253	1200	50	59.24661	0.986378	97.49005
27	Serdang Bedagai	3326	3215	94	59.0412	3.594462	98.48225
28	Nias Utara	252	252	0	59.16591	1.740375	98.7828
29	Labuhan Batu	2361	2275	85	58.80939	0.708609	97.82864
30	Asahan	3220	3012	200	60.0791	3.865392	98.30884
31	Labuhan Batu Utara	1295	1241	53	61.46432	3.174098	99.50061

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32	Tapanuli Selatan	942	907	31	62.10374	2.583333	98.81667
33	Toba Samosir	2626	2564	52	71.79763	1.577493	99.27856

Table 1 display number of Confirmed, Recovered, Died, and the completion of the second dose of vaccine from From the data in Table 1, we can use and describe it in the form of a coropleth map as a method of cartographic representation that uses color differentiation or color gradations to fill polygons/districts separated by isolines which are generally administrative areas. The following is a choropleth map of the spread of COVID-19 based on table 1 data on the number of Covid-19 distributions in each district in North Sumatra Province.

The distribution mapping in the form of a map will display information on the boundaries of each district in the province of North Sumatra and display color information for each region with a description of the yellow area being a low risk zone, the green color is a safe area from covid-19, besides that when the user clicks on the area If you want it, it will display information in the form of the name of the sub-district area, Confirmed, Recovered Patients, Died, and vaccine achievements. With a mapping picture like this, it will be easier for the public to find out which areas are being affected by COVID-19.

Main Dashboard

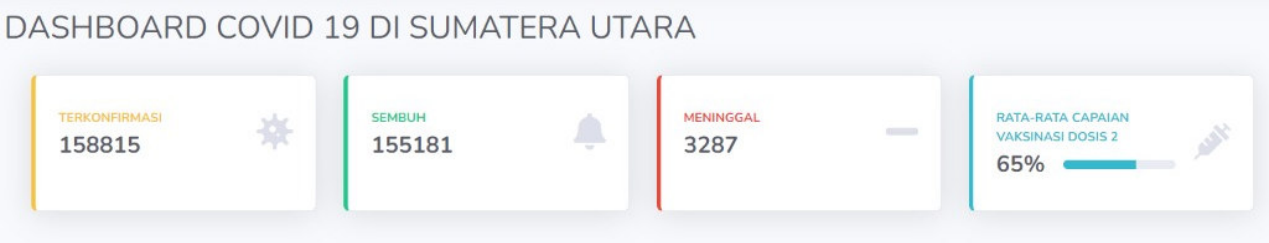


Figure 8. Dashboard Covid 19

On the main dashboard of the website page, visitors will inform the total number of cases from the distribution of all regencies in North Sumatera Province which consists of total confirmed, recovered and died and vaccine achievement.

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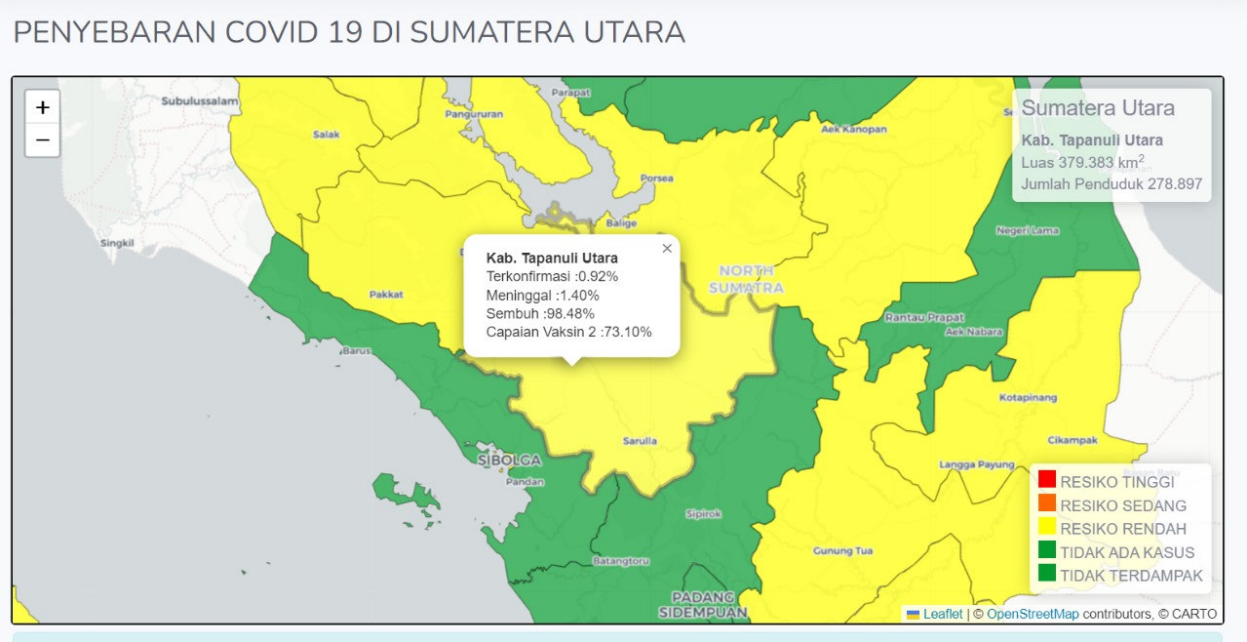


Figure 9. Covid-19 choropleth map

In the figure 8 it can be seen that the results of the clustering consist of 2 color zones of the Covid-19 virus infection area. This page aims to provide information on the graph of the development of Covid 19 cases until September 2022 in Figure 10, the number of vaccines given and vaccine targets in Figure 11, the number of specimen actions in categories: a. antigens and PCR in figure 12 and Graphic of the number of hospitals and beds for ICU patients, b. Isolation in every district in North Sumatra Province.

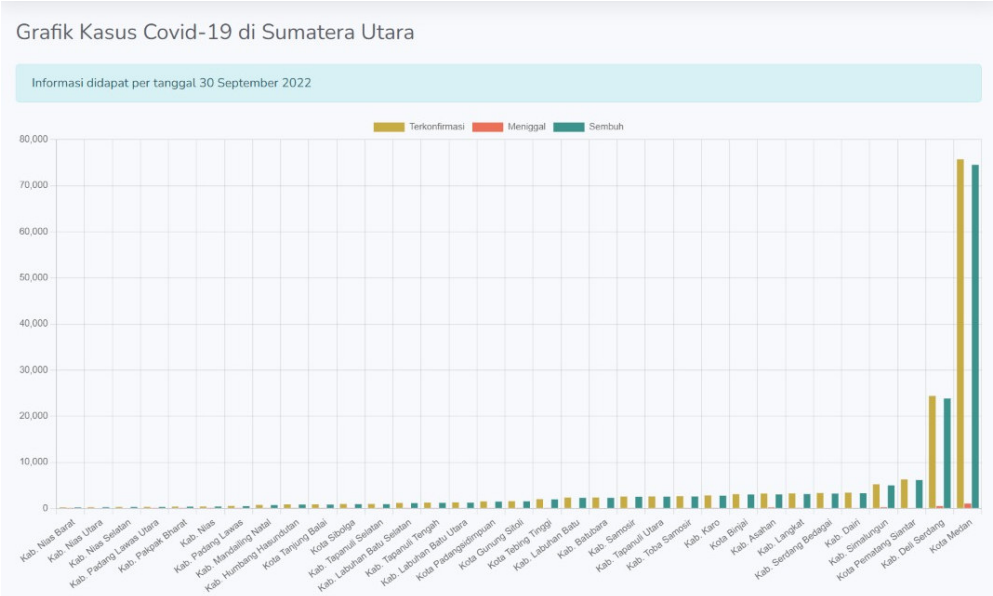


Figure 10. Graphic of Covid-19 cases

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Figure11. Graphic of Covid-19 vaccine and vaccine target

a. Antigens **b. PCR**

Figure 12. Graphic of the number of specimen actions in categories.

a. ICU **b. Isolation**

Figure 13. Graphic of the number of hospitals and beds for patients: a. ICU, b. Isolation

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Road network analysis in Medan city using Floyd-Warshall algorithm for route optimization based on GPS

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Abstract. *The regional socio-demographic makeup has an impact on how well the transportation system functions. The purpose of this study is to, particularly using GPS, identify the shortest route between two specified sites, namely the beginning and finishing points of several sub-districts in Medan City. The result requires multiple processes, including gathering the coordinates of street names and road lengths, which are retrieved from Google Maps. In order to present data, graphs are used. The Floyd-Warshall algorithm uses data analysis using a PHP programming language, Javascript, and MySQL database enabled HTML Web application. The system's functioning has passed all tests using the Black Box approach, according to the results. Compare the final W ij and Z* matrix calculations produced by the system to the identical hand calculations as a test. The system's reliability was tested, and the results revealed that it functioned well and could be approved. Since there are no path deviations, the anticipated outcomes are what was anticipated.*

Keywords: *Shortest path, network model, Floyd-Warshall Algorithm, Metode Waterfall, GPS. WEB*

Introduction

The road is one of the most practical forms of transportation in the modern world, and it is frequently utilized for both travel and transportation. The manipulation of the shortest path between different locations appears to be a significant issue with the road network. By creating shortest-path algorithms for road networks, numerous products and applications are produced to address or circumvent challenges. [1]

Finding the shortest route between two vertices in a directed graph with weighted edges is known as the shortest path problem in graph theory [2]. The data used in this study comes from the observation of the two-way road network, which is divided into several sub-districts in Medan City. Only the Medan City Sub-District was observed using a google map with the goal of learning about the roads in the Medan district and the length of a road traversed. All of the

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graph's vertices correspond to the street names in the Medan Subdistrict; its edges are the roads that connect those street names; and its edge weights indicate the size of the road network.

As there are numerous existing roads connecting different locations, it can be challenging to identify the shortest route because there may be obstacles on the primary, shortest route. To prevent losses, the necessity to identify the shortest road and the quickest journey time is also taken into consideration. The graph's complexity will increase as the number of dots and lines increases [3]. Large cities like Medan typically have a complicated transportation system. When a destination has never been visited before, it is frequently challenging to identify the route that must be followed to go there. Yet, people will usually recognize the road that must be taken to get to the destination they typically visit. People have so far asked others who are quite knowledgeable about the city's transportation system. As a result, their journey lengthens and can call for more time and effort than they have available.

A graph algorithm that employs the Floyd-Warshall method can be used to find the shortest path. The Floyd-Warshall algorithm, which is used in a dynamic program to determine all the shortest routes between any conceivable pair of locations (all pairs of shortest path problems), is extremely efficient in addressing the optimum path problem. With the help of the application, this algorithm can find the shortest route between two stated and anticipated destinations. It also has good effects on travel expenses, as it can predict the cost of fuel-efficient vehicles based on the lowest possible distance.

Methods

This study used observation as the primary method of data collection, gathering secondary information in the form of street names in the Medan subdistrict and calculating the separation between each network node using Google Maps. It applies the waterfall method for creating the shortest route system.

Waterfall method

One of the software development life cycle models (SDLC) that includes analysis, design, implementation, testing, and maintenance stages is the waterfall approach [4]. In Figure 1 [5], the waterfall approach is explained.

Hardware and software are both a part of the system development in Figure 1 from the requirements analysis phase. Data flow diagram design is carried out throughout the design phase with the goal of facilitating comprehension of the system being constructed. The period of activities to put all designs into practice has started. At this time, the Floyd-Warshall algorithm is programmed using HTML Web Applications, with assistance from the PHP and JavaScript programming languages, and a MySQL Database. The approximate value is referred to as the "optimal value" for each point between the two vertices.

The testing stage involves determining the shortest path. The three exams that make up this study are as follows: [4]

1. Testing in a "black box" ignores the internal logical organization of the software in favor of focusing on a core component of the system. Typically, system testing for black boxes is done.
2. The initial W ij matrix created by the system and the initial W ij matrix calculated manually are compared in order to test the calculation results. The system is

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functioning as planned if the final matrix results are retrieved from the system with the final matrix manually calculated.

3. By traveling along and viewing the road network in the Medan sub-district and comparing the paths with the system's calculated findings, it is possible to verify the accuracy of the path and mileage that the system generates.

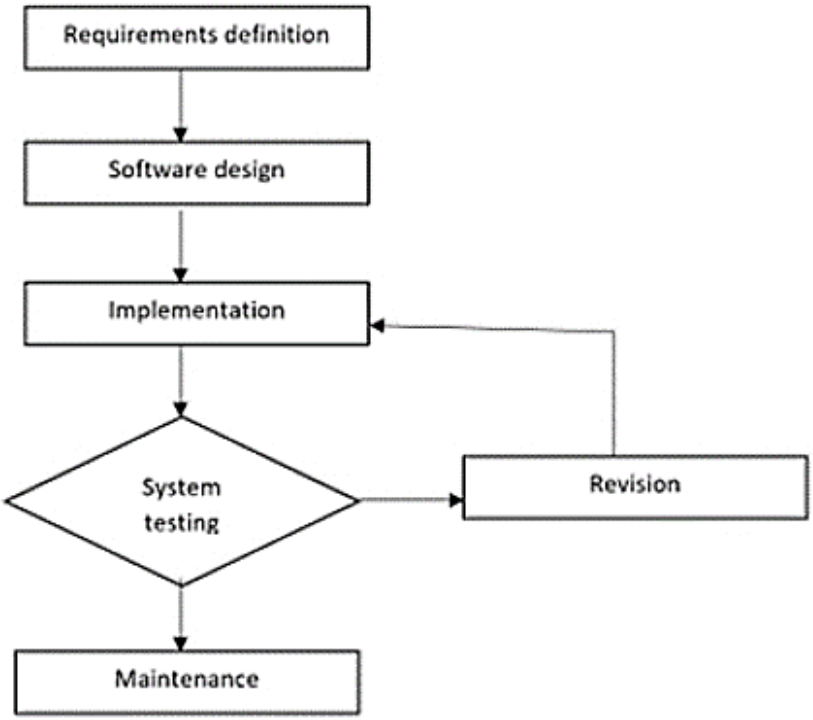


Figure 1. Stages of the Waterfall Method

Floyd-Warshall algorithm

The Floyd-Warshall algorithm is a variation on dynamic programming, a technique for problem solving that views the desired outcome as an interconnected collection of choices. In other words, the solution is created from the solutions that were generated from the preceding stage, and more than one solution may be possible. The selection of the shortest path between two or more places given on a digital map is the problem that is the subject of discussion in this paper, and it is solved using the Floyd-Warshall method. In order to calculate the distance between nodes (crossing points), the Floyd-Warshall algorithm compares each possible route variation to the distance between each point and the destination point. There is a numerical number on the line that connects the nodes that represents the importance of the distance. Each line will be used as a component in the Floyd-Warshall algorithm's calculations to find the shortest path. [6]

The Floyd-Warshall algorithm is described in [7] and goes like this:

1) $W = W_0$

2) $For\ k = 1\ to\ n, do :$
   $For\ i = 1\ to\ n, do :$

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$For\ j = 1\ to\ n, do:$
$If\ W_{[i,j]} > W_{[i,k]} + W_{[k,j]}$
$Then\ replace\ W_{[i,j]}\ with\ W_{[i,k]} + W_{[k,j]}$

3) $W^* = W$

Declarations :

$W = matrix$
$W_0 = first\ adjacency\ matrix\ graph$
$K = iteration\ 1\ to\ n$
$i = first\ point\ v_i$
$j = first\ point\ v_j$
$W^* = result\ of\ matrix\ after\ comparison$

The Floyd-Warshall algorithm creates a matrix at each iteration of the shortest path that corresponds to the number of iterations (k). For high values in particular, this will slow down the operation. Floyd-Warshall method is frequently used to determine the shortest path, despite the Floyd-Warshall algorithm's slower processing speed.

Results and discussion

A graph of the road coordinate data from the Medan sub-district is created as the first step in the process of finding the shortest path, as shown in Figure 2.

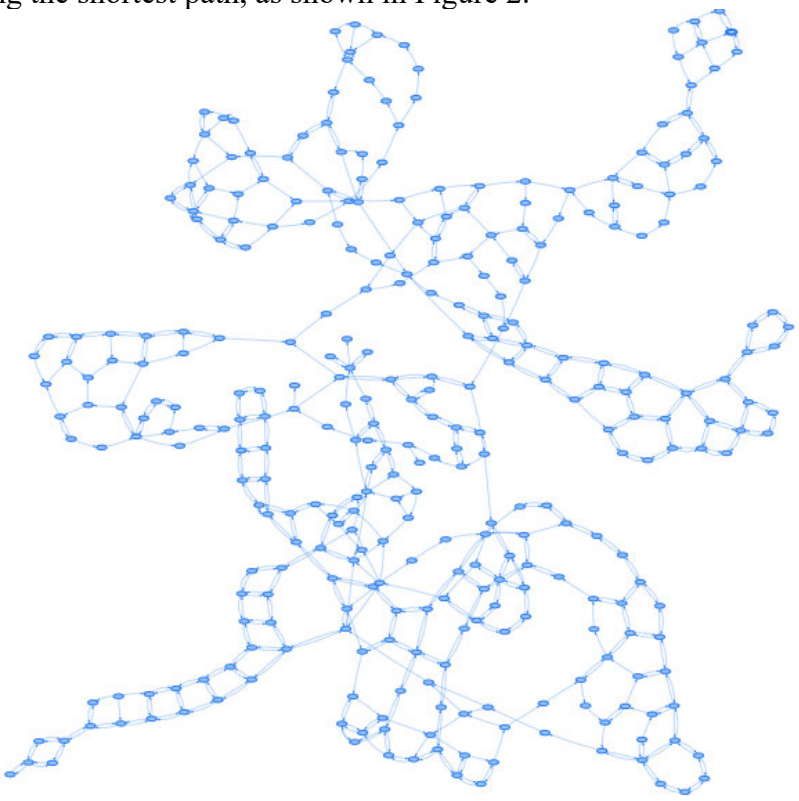
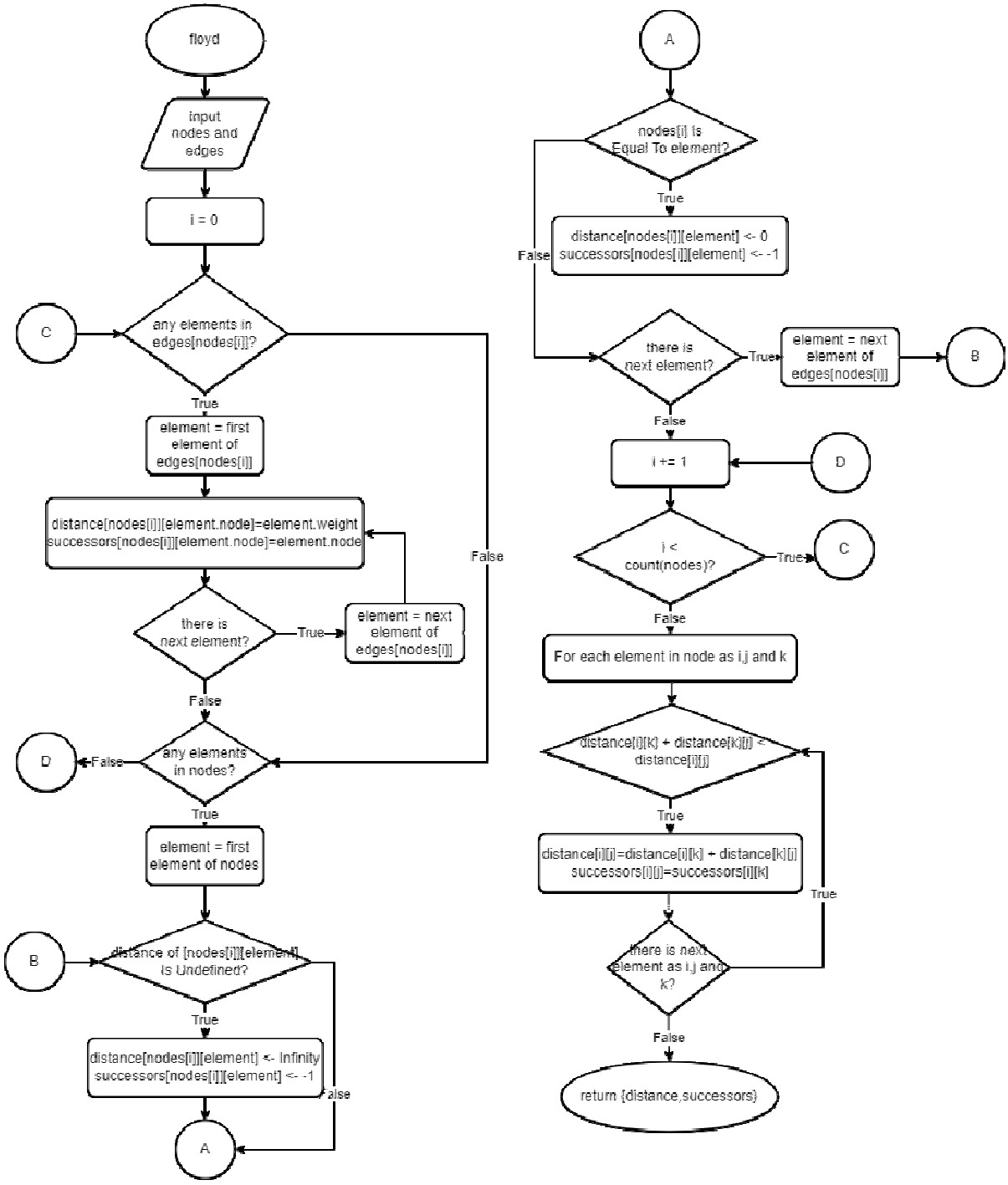


Figure 2. Road data in graph form

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In the Medan sub-district, there are 330 locations in the road network, as shown in Figure 2. In this instance, the point stands for the road's coordinates. According to information from Google Map in the Medan sub-district, the existent points are linked to one another according to the road coordinates. a road network made up of 686 sides.

The Flowchat algorithm Warshall - Floyd



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Floyd-Warshall algorithm programming

Using a MySQL database and an HTML Web application supported by the PHP and JavaScript programming languages, the Floyd-Warshall algorithm is programmed to produce a display similar to this.

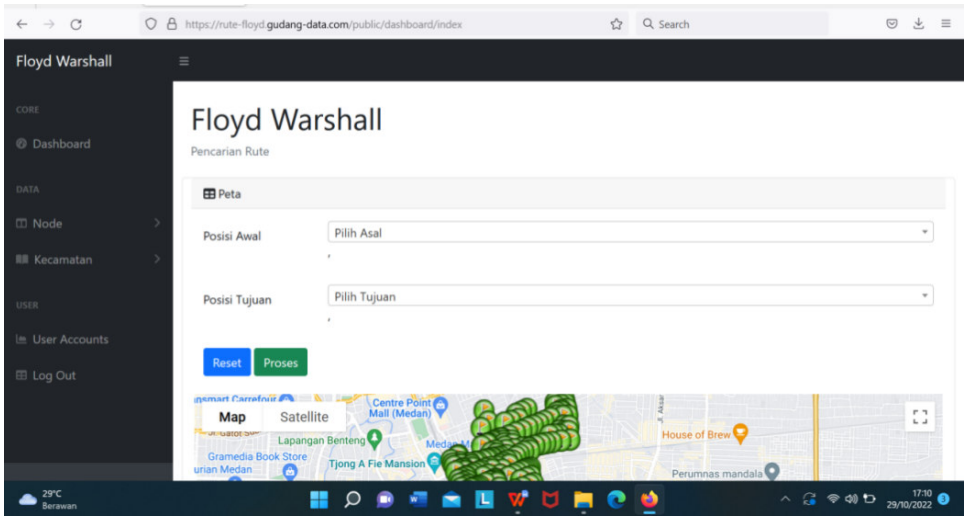


Figure 3. Web application display

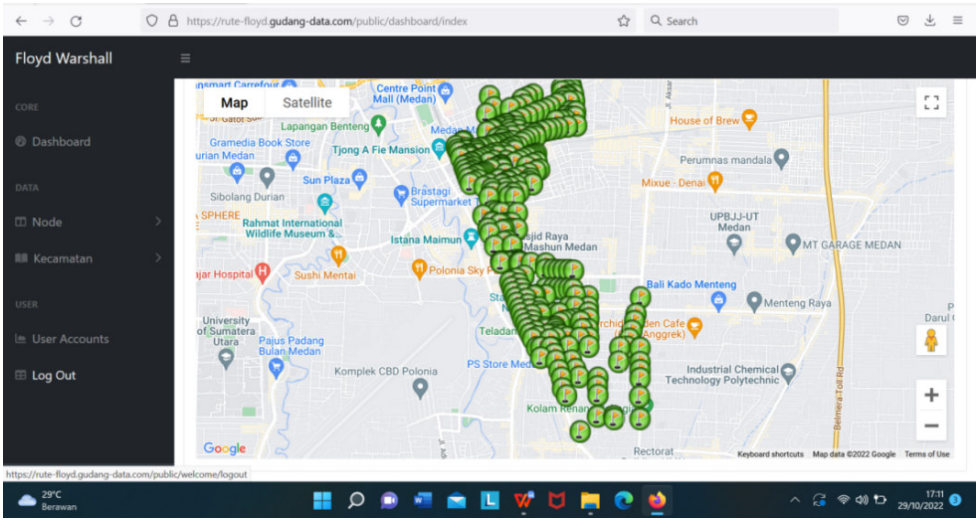


Figure 4. Web Application Display

Following the acquisition of nodes and pathways, the Floyd-WWarshall method is used to calculate the shortest path between all network nodes, and the resulting initial W-ij matrix and initial Z-ij matrix are then obtained. The initial W ij matrix can be used to determine the shortest path between any two points, whereas the initial Z ij matrix can determine the shortest distance between any two points.

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Shortest Route Search

It is possible to determine the shortest route in the Medan sub-district using the system that has been developed to calculate the distance between the starting point and the target position. The Floyd-Warshall calculation's results offer the most advantageous travel route selection in terms of distance.

The system's functioning has passed all tests using the Black Box approach, according to the results. The purpose of the second test is to determine whether the system-generated final W ij and final Z* matrix calculations agree with the findings of the manual calculations. The final step is to evaluate the system's dependability. The system dependability test findings indicate that the system is operating as intended and that it can be trusted. As there are no path deviations, the expected outcomes are exactly what was anticipated.

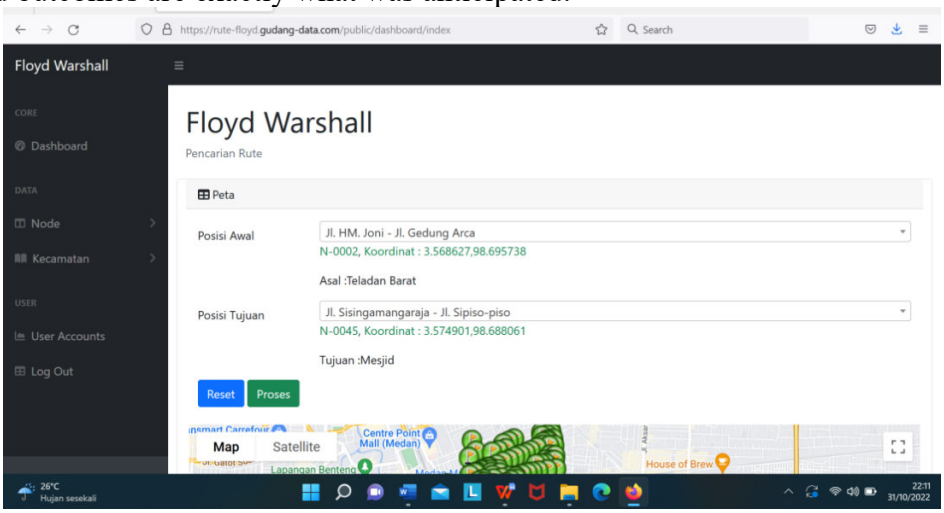


Figure 5. The web application displays looking for the shortest path

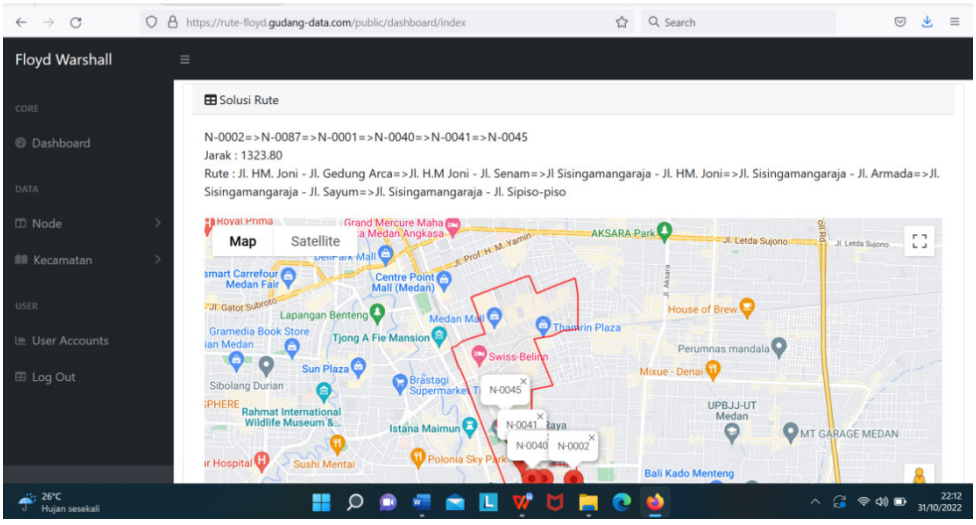


Figure 6. Web Application View looking for Shortest Path

Conclusions

The shortest path search application employing the Floyd-Warshall algorithm can be deployed in the Medan sub-district based on the findings of this research investigation. The process of

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converting the road coordinate data collected from Google Maps into the shape of a road network initiates the search for the shortest path between the starting place and the destination position. After that, the network is transformed into a neighboring matrix, and the Floyd-Warshall algorithm is used to determine the shortest path.

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Implementation of North West Corner (NWC) Method and Modified Distribution (MODI) method in optimizing fish distribution costs in CV. horizon group sibolga

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Abstract. *The calculation of distribution costs using the transportation method seeks to solve the problem of the source of the goods being sent to the destination so that the most optimal amount of transportation costs will be obtained to maximize profits. CV. Horizon Group is a company that provides raw fish for sale to fish processing consumers. The company is located at Gatot Subroto street Number 108 Pondok Batu Sarudik, Central Tapanuli Regency, North Sumatra Province. In this study, the North West Corner method will be used to find an initial feasible solution, and the Modified Distribution method will be used as an optimization test. If the test results show an optimal solution, then the allocation has been optimal and can be said to have reached the most profitable value. Before the calculation, the company spends a year's distribution costs of Rp. 963,000,000. From the study results, the total cost obtained after using the North West Corner method as the initial solution was Rp. 928,831,000, and after using the Modified Distribution method as the optimal solution, the total distribution cost is Rp. 923,058,000. So that the method used can save costs of Rp. 39,942,000, with a percentage of 4.14%.*

Keywords: optimization, transportation problems, north west corner, modified distribution.

Introduction

Transportation problems are generally related to product distribution from various sources to several sales locations. Distribution plays a vital role because without the correct distribution pattern, and this process can be costly and result in waste in terms of time, distance and energy. Distribution costs are the total number of distribution channels, including all activities related to delivering manufactured goods to a company to buyers or prospective buyers. The calculation of distribution costs using the transportation method seeks to solve the problem of the source of the goods being sent to the destination so that the most optimal amount of transportation costs can be obtained and maximize profits [1].

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CV. Horizon Group is a company that provides raw fish for sale to fish processing consumers. Types of fish the company provides include skipjack tuna, yellowfin tuna, and sare. The company is located at Gatot Subroto street Number 108 Pondok Batu Sarudik, Central Tapanuli district, North Sumatra province. Distribution problems in CV. Horizon Group Sibolga is the cost of distribution and has not been optimal in maximizing the capacity of transportation equipment to pursue delivery targets to customers.

This research will use the North West Corner (NWC) and Modified Distribution (MODI) methods. The North West Corner method is a transportation method in which the source and destination locations are sorted from left to right and from top to bottom in a data matrix map [2]. The North West Corner method is faster in making decisions and without being too complicated in the placement of units to be distributed to the place of demand for use with other methods; of course, there are considerations in terms of distribution costs, but if there is the exact distribution cost, it will undoubtedly be longer in retrieval [3]. In Modified Distribution method, we can get the opportunity cost of empty cells without writing the loop. After getting the opportunity cost of all cells, we have to select the cell with the highest positive opportunity cost for including it in the modified solution. Steps in Modified Distribution method [4].

Based on this background, it can be formulated that the problem of this research is how the optimal transportation costs in the distribution of fish in CV. Horizon Group Sibolga using the North West Corner (NWC) and Modified Distribution (MODI) method. This study aimed to determine the optimal transportation costs in the distribution of fish in CV. Horizon Group Sibolga using the North West Corner (NWC) and Modified Distribution (MODI) methods.

Given the breadth of the problem to be studied, a problem limitation will be given, namely:

1. The initial solution method used is the North West Corner (NWC) method and the Modified Distribution (MODI) method to test the optimization of the initial solution results.
2. The data used is secondary data along January-December 2021, covering:
   - Data supply of fish at each source.
   - Data on fish demand from consumer factories (destinations).
   - Data on distribution costs that the company must issue for each shipment of fish from each fishing port for each consumer.
3. Fish distribution data includes three fishing ports and four consumer factories.
4. Delivery of production is sent using truck transportation.

Literatur review

Optimization

The word “optimal” comes from Latin and means “highest ideal” and “Optimus”, which means “the best”. Therefore, optimizing refers to bringing whatever we encounter toward the best end state. So, optimizing is doing something methodically to the constraint function to find better answers, solutions, or designs [5]. In optimization problems, the function must be maximized or minimized. The function that is being optimized is called the objective function or performance index. Functions are quantities such as cost, profit, efficiency, size, shape, weight, output, and so on. Cost minimization or profit maximization is a crucial consideration for most organizations; for example, weight minimization is the primary consideration for aerospace applications [6].

So according to the concept above, optimizing is the process of maximizing or minimizing the objective function without violating the specified limits, by setting a series of variable parameters

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that affect the objective function and constraints in order to find better answers, better solutions, or better designs.

Linear programming

Linear programming is a mathematical technique designed to help operations managers plan and make decisions necessary to allocate resources [7]. The objective of a linear programming problem is to obtain an optimal solution. Linear programming problems deal with the problem of minimizing or maximizing a linear objective function in the presence of a system of linear inequalities. The linear objective function represents cost or profit. This method is helpful to choose the best feasible point among the many possible feasible points. A point minimizing the objective function and satisfying the set of linear constraints is called a "feasible point" [8].

A linear programming problem is an optimization problem for which we do the following [9]:

1. We attempt to maximize (or minimize) a linear function of the decision variables. The function that is to be maximized or minimized is called the objective function.
2. The values of the decision variables must satisfy a set of constraints. Each constraint must be a linear equation or linear inequality.
3. A sign restriction is associated with each variable. For any variable x_i , the sign restriction specifies that x_i must be either nonnegative ($x_i \geq 0$) or unrestricted in sign.

The transportation problem

The problem of public transportation is concerned with distributing any commodity from any group of supply centers, called sources, to any group of receiving centers, called destinations, in such a way as to minimize the total cost of distribution. Each source has a specific supply of units to distribute to destinations, and each destination has a specific demand for units to be received from the source [10].

In general, a transportation problem is specified by the following [9]:

1. A set of m supply points from which a good is shipped. Supply point i can supply at most s_i units.
2. A set of n demand points to which the good is shipped. Demand point j must receive at least d_j units of the shipped good.
3. Each unit produced at supply point i and shipped to demand point j incurs a variable cost of c_{ij}.

Letting z be the total distribution cost and x_{ij} ($i = 1, 2, \ldots, m$; $j = 1, 2, \ldots, n$) be the number of units to be distributed from source i to destination j, the linear programming formulation of this problem is

Minimize:

$$z = \sum_{i=1}^{m} \sum_{j=1}^{n} c_{ij} x_{ij} \tag{1}$$

Subject to [10]:

$$\sum_{j=1}^{j=n} x_{ij} \leq s_i \qquad (i = 1, 2, \ldots m) \qquad \text{(Supply constraints)} \tag{2}$$

$$\sum_{i=1}^{i=m} x_{ij} \geq d_i \qquad (j = 1, 2, \ldots n) \qquad \text{(Demand constraints)} \tag{3}$$

$$x_{ij} \geq 0 \qquad (i = 1, 2, \ldots m) \text{ and } (j = 1, 2, \ldots n)$$

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Northwest corner method

The northwest-corner rule requires that we start in the upper-left-hand cell (or northwest corner) of the table and allocate units to shipping routes as follows [7]:

- Exhaust the supply (factory capacity) of each row before moving down to the next row.
- Exhaust the (warehouse) requirements of each column before moving to the next column on the right.
- Check to ensure that all supplies and demands are met.

The northwest corner rule is easy to use and produces a viable solution but ignores costs. This should be considered only as a preliminary solution. This method only ensures that no underlying variable will be assigned a negative value (because no right-hand side becomes negative) and also that every supply and demand constraint is satisfied (because each row and column is eventually crossed out) [9]. The first method is "mechanical" in nature in that its main purpose is to provide a starting (basic feasible) solution regardless of the cost. The remaining two are heuristics that seek a better-quality (smaller objective value) starting solution [11].

The North West Corner Method Algorithm [11] :

- Allocate as much as possible to the selected cell, and adjust the associated amounts of supply and demand by subtracting the allocated amount.
- Cross out the row or column with zero supply or demand to indicate that no further assignments can be made in that row or column. If both a row and a column net to zero simultaneously, cross out one only, and leave a zero supply (demand) in the uncrossed-out row (column).
- If exactly one row or column is left uncrossed out, stop. Otherwise, move to the cell to the right if a column has just been crossed out or below if a row has been crossed out. Go to step 1.

Modified distribution method

Modified Distribution (MODI) method is a transportation case solution developed from the Stepping Stone method. Compared to its predecessors, the advantage of this method is that cell determination is definite and fast. The solution using the MODI method is a variation of the Stepping Stone method based on the dual formulation. MODI differs from the Stepping Stone method in that with MODI. It is not necessary to specify all iterations of non-basic variables. The MODI method calculates the index of the number (both rows and columns) to be incremented without describing all loops (closed paths). The MODI method is enough to trace a closed path, the same as the Stepping Stone method, only in the MODI method, the initial allocation is determined first. It is continued by doing the steps sequentially [12].

The Modified Distribution Method Algorithm [8]:

- Introduce the variables u_i and v_j corresponding to i^{th} row and j^{th} column, respectively. Write u_i in front of each i^{th} row and v_j at the bottom of each j^{th} column. Initial value $u_i = 0$ for maximum allocation amount.
- For basic cells (which contain allocations), calculate $u_i + v_j = c_{ij}$. This relation assigns value to all u_i and v_j .
- For nonbasic cells (which have no allocations), Calculate the magnitude of the cost change that occurs from the evaluation of empty cells (I_{ij}) by developing the formula: $I_{ij} = u_i + v_j - c_{ij}$. If one or more $I_{ij} > 0$ it means that the initial feasible solution is not optimal and still needs to be reallocated. The cell with the biggest value I_{ij} will be selected as the entering

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variable and allocated as many as possible according to supply and demand constraints. Reallocation causes changes in base cells to non-basic cells and vice versa. When the solution is still not optimal, the same process is carried out in the next iteration to determine the value of the dual variable, and the opportunity cost of empty cells, and the computation stops if all values of $I_{ij} \leq 0$.

- If all value of $I_{ij} \leq 0$, it can be shown that the solution is optimal.

Methodology

This research was conducted at CV. Horizon Group is located in the Sibolga Archipelago Fisheries Port area, precisely on Gatot Subroto street Number 108 Pondok Batu Sarudik, Central Tapauli Regency, North Sumatra Province, with approximately one month of research time. The data used in the study were obtained through intermediary media or indirectly, in the form of library data, documents or written reports, and other information related to the distribution of fish in CV. Horizon Group.

The following steps will be taken in conducting research :

1. Conduct a literature study by collecting reference materials, studying and digging up information from books, articles, papers, journals and papers, and internet sites regarding to the North-west Corner method and Modified Distribution method.
2. Analyze the transportation method to be used, namely the North-west Corner Method as the initial solution and the Modified Distribution method as the optimal solution.
3. Collect fish distribution data from CV. Horizon Group in January-December 2021, including inventory, demand, and distribution cost data that the company must issue for each fish shipment.
4. Create a transportation table from the data obtained and create a mathematical model of transportation problems.
5. Solve the initial solution using the Northwest Corner method, then continue using the Modified Distribution method to get the optimal solution.
6. Compare with the company spends a year's distribution costs to calculate the eficiency.

Results and discussion

Data collection

Data collection is done in CV. Horizon Group Sibolga, which is located on Gatot Subroto street number 108 Pondok Batu Sarudik, Central Tapanuli Regency, North Sumatera Province. The data collected is fish distribution data from CV. Horizon Group in January-December 2021, including:

- Data supply of fish at each Fishing ports (source).
- Data on fish demand from consumer factories (destinations).
- Data on distribution costs that the company must issue for each shipment of fish from each tank to each consumer

CV. Horizon Group has three Fishing ports (sources) of fish stocks in Central Tapanuli Regency and Aceh. The Fishing Port is the Fishing Port of Horizon, Aceh, and the Sibolga Archipelago Fisheries Port. The fish will be sent to four destinations, namely Jakarta, Medan, Pekanbaru, and Jambi.

Data on fish supply

Data on the capacity of fish stocks in each Fishing port (source) in the period January – December 2021 can be seen in Table 1.

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Table 1. Fish supply capacity January–December 2021

Num.	Source	Total Inventory (Kg)
1	Fishing Port of Horizon	1,148,000
2	Archipelago Fishing Ports Sibolga	278,000
3	Fishing Port of Aceh	668,000

Source : CV. Horizon Group

Data on fish demand

The data used in this study are data on the demand, supply, and transportation costs of fish in January – December 2021. Data on fish demand from each Fishing port (source) is shown in Table 2.

Table 2. Distribution of fish in January–December 2021

Num.	Source	Destination	Total Inventory (kg)
1.	Fishing Port of Horizon	Jakarta	500,000
		Medan	287,000
		Jambi	132,000
		Pekanbaru	229,000
2.	Archipelago Fishing Ports Sibolga	Jakarta	148,000
		Medan	102,000
		Jambi	14,000
		Pekanbaru	14,000
3.	Fishing Port of Aceh	Jakarta	220,000
		Medan	170,000
		Jambi	105,000
		Pekanbaru	173,000

Source : CV. Horizon Grup

Data on distribution costs

The company has to spend distribution cost data on each fish shipment from every hand to every consumer. In distribution, CV. Horizon Group uses its means of transport. There are two types of transportation equipment available at the company, Colt diesel and Hino 500. There are 3 Colt diesel vehicles with a 7 ton capacity and 8 Hino 500 vehicles with a 20 ton capacity. Transportation cost data can be seen in Table 3.

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Table 3. Transportation cost data from each fishing port (source) to consumer (destination) in January–December 2021

Num.	Source	Destination	Cost (Rp/ Kg)
1.	Fishing Port of Horizon	Jakarta	600
		Medan	352
		Jambi	336
		Pekanbaru	313
2.	Archipelago Fishing Ports Sibolga	Jakarta	730
		Medan	329
		Jambi	343
		Pekanbaru	343
3.	Fishing Port of Aceh	Jakarta	655
		Medan	353
		Jambi	360
		Pekanbaru	306

Source : CV. Horizon Grup

Data processing

Table 4. Data on supply capacity, demand and transportation costs in the form of a transportation matrix

Transportation Cost Data					
Source	Destination				Supply
	Jakarta	Medan	Jambi	Pekanbaru	
Fishing Port of Horizon	600	352	336	313	1,148,000
Archipelago Fishing Ports Sibolga	730	329	343	343	278,000
Fishing Port of Aceh	655	353	360	306	668,000
Demand	868,000	559,000	251,000	416,000	

The data obtained from Table 4 will be made a mathematical model with the objective function and the constraint function of the linear program formulation as follows:

Minimize:

$$z = \sum_{i=1}^{m}\sum_{j=1}^{n} c_{ij}x_{ij}$$

$$z = \sum_{i=1}^{3}\sum_{j=1}^{4} c_{ij}x_{ij}$$

$$z = c_{11}x_{11} + c_{12}x_{12} + c_{13}x_{13} + c_{14}x_{14} + c_{21}x_{21} + c_{22}x_{22} + c_{23}x_{23} + c_{24}x_{24} + c_{31}x_{31} + c_{32}x_{32} + c_{33}x_{33} + c_{34}x_{34}$$

$$z = 600x_{11} + 352x_{12} + 336x_{13} + 313x_{14} + 730x_{21} + 329x_{22} + 343x_{23} + 343x_{24} + 655x_{31} + 353x_{32} + 360x_{33} + 306x_{34}$$

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Subject to:

Supply constraints

$$\sum_{j=1}^{4} x_{ij} \le s_i; \qquad i = 1,2,3$$

$x_{11} + x_{12} + x_{13} + x_{14} \le 1{,}148{,}000$
$x_{21} + x_{22} + x_{23} + x_{24} \le 278{,}000$
$x_{31} + x_{32} + x_{33} + x_{34} \le 668{,}000$

Demand constraints

$$\sum_{i=1}^{3} x_{ij} \ge d_i; \qquad j = 1,2,3,4$$

$x_{11} + x_{21} + x_{31} \ge 868{,}000$
$x_{12} + x_{22} + x_{32} \ge 559{,}000$
$x_{13} + x_{23} + x_{33} \ge 251{,}000$
$x_{14} + x_{24} + x_{34} \ge 416{,}000$

$x_{ij} \ge 0$, for all i and j

Information:

- z = Total distribution cost
- c_{ij} = Transportation cost per unit of goods from source i to destination j
- x_{ij} = Number of goods distributed from source i to destination j
- s_i = Number of goods supplied from source i
- d_j = quantity of goods demanded by destination j

Calculation of initial solution with North West Corner Method

Table 5. Results of the north west corner method

Source	Destination				Supply
	T_1	T_2	T_3	T_4	
A_1	600 **868,000**	352 **280,000**	336	313	1,148,000
A_2	730	329 **278,000**	343	343	278,000
A_3	655	353 **1,000**	360 **251,000**	306 **416,000**	668,000
Demand	868,000	559,000	251,000	416,000	

Note:

A_1 = Source 1 (Fishing Port of Horizon)
A_2 = Source 2 (Archipelago Fishing Ports Sibolga)
A_3 = Source 3 (Fishing Port of Aceh)
T_1 = Destination 1 (Jakarta)
T_2 = Destination 2 (Medan)
T_3 = Destination 3 (Jambi)
T_4 = Destination 4 (Pekanbaru)

Total Cost = 868,000(600) + 280,000(352) + 278,000(329) + 1000(353) + 251,000(360) + 416,000(306)
= 520,800,000 + 98,560,000 + 91,462,000 + 353,000 + 90,360,000 + 127,296,000
= 928,831,000

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Calculation of optimal solution with modified distribution

The extra column on the left side of the table with the variables u_i and the extra row on the top with the variable v_j represents the row and column values that must be calculated in the Modified Distribution method. The value is calculated for all allocation cells with the formula: $u_i + v_j = c_{ij}$. Calculate the row and column index of the filled cells with the initial value $u_1 = 0$.

Table 6. Initial solution with all values of u_i and v_j

	v_j	$v_1 = 600$	$v_2 = 352$	$v_3 = 359$	$v_4 = 305$	
u_i	Destination / Source	**T1**	**T2**	**T3**	**T4**	**Supply**
$u_1 = 0$	A1	600 868,000	352 280,000	336	313	1,148,000
$u_2 = -23$	A2	730	329 278,000	343	343	278,000
$u_3 = 1$	A3	655	353 1,000	360 251,000	306 416,000	668,000
	Demand	868,000	559,000	251,000	416,000	

Furthermore, the following formula is used to evaluate the empty cells to determine the opportunity cost of the nonbasic variable. $I_{ij} = u_i + v_j - c_{ij}$ where I_{ij} equal to the increase in cost or decrease in cost that might occur by allocating to a cell, for all the blank cells in Table 6, the formula returns the following values.

Table 7. Result calculate the fare change index from an empty cell

Empty cell	$I_{ij} = u_i + v_j - c_{ij}$	Result
$A_1 \rightarrow T_3$	$I_{13} = u_1 + v_3 - c_{13}$	$0 + 359 - 336 = 23$
$A_1 \rightarrow T_4$	$I_{14} = u_1 + v_4 - c_{14}$	$0 + 305 - 313 = -8$
$A_2 \rightarrow T_1$	$I_{21} = u_2 + v_1 - c_{21}$	$-23 + 600 - 730 = -153$
$A_2 \rightarrow T_3$	$I_{23} = u_2 + v_3 - c_{23}$	$-23 + 359 - 343 = -7$
$A_2 \rightarrow T_4$	$I_{24} = u_2 + v_4 - c_{24}$	$-23 + 305 - 343 = -61$
$A_3 \rightarrow T_1$	$I_{31} = u_3 + v_1 - c_{31}$	$1 + 600 - 655 = -54$

This calculation shows that cell c_{13} will decrease the cost by 23 per unit. Because of the value of the opportunity cost of cell c_{13}, the cell is selected as the entering nonbasic variable; it must be determined the stepping stone path of the cell again determine how many units will be reallocated.

Table 8. Relocation path Second iteration optimal solution with MODI

Source	**Destination**				**Supply**
	T1	T2	T3	T4	
A1	600 868,000	(-) 352 280,000 →	336 (+)	313	1,148,000
A2	730	329 278,000	343	343	278,000
A3	655	353 1,000 (+) ←	360 251,000 (-)	306 416,000	668,000
Demand	868,000	559,000	251,000	416,000	

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The values of the variables u_i and v_j in Table 8 must be recalculated using the formula $u_i + v_j = c_{ij}$ for the cells that have been allocated. Calculate the row and column index of the filled cells with the initial value $u_1 = 0$.

Table 9. New values of u and v for iteration 1

	v_j	$v_1 = 600$	$v_2 = 352$	$v_3 = 336$	$v_4 = 305$	
u_i	**Destination** / **Source**	T_1	T_2	T_3	T_4	**Supply**
$u_1 = 0$	A_1	600 868,000	352 29,000	336 251,000	313	1,148,000
$u_2 = -23$	A_2	730	329 278,000	343	343	278,000
$u_3 = 1$	A_3	655	353 252,000	360	306 416,000	668,000
	Demand	868,000	559,000	251,000	416,000	

Furthermore, the following formula is used to evaluate the empty cells to determine the opportunity cost of the nonbasic variable. $I_{ij} = u_i + v_j - c_{ij}$

Where I_{ij} equals the increase in cost or decrease in cost that might occur by allocating to a cell, for all the blank cells in Table 9, the formula returns the following values.

Table 10. Result calculate the fare change index from an empty cell iteration 1

Empty Cell	$I_{ij} = u_i + v_j - c_{ij}$	Result
$A_1 \rightarrow T_4$	$I_{14} = u_1 + v_4 - c_{14}$	$0 + 305 - 313 = -8$
$A_2 \rightarrow T_1$	$I_{21} = u_2 + v_1 - c_{21}$	$-23 + 600 - 730 = -153$
$A_2 \rightarrow T_3$	$I_{23} = u_2 + v_3 - c_{23}$	$-23 + 336 - 343 = -30$
$A_2 \rightarrow T_4$	$I_{24} = u_2 + v_4 - c_{24}$	$-23 + 305 - 343 = -61$
$A_3 \rightarrow T_1$	$I_{31} = u_3 + v_1 - c_{31}$	$1 + 600 - 655 = -54$
$A_3 \rightarrow T_3$	$I_{33} = u_3 + v_3 - c_{33}$	$1 + 336 - 360 = -23$

Since there is no positive opportunity cost, so the solution in table 9 is optimal.

Total Cost = (600x868.000) + (352x29,000) + (336x251,000) + (329x278,000) + (353x252,000) + (306x416,000)

= 520,800,000 + 10,208,000 + 84,336,000 + 91,462,000 + 88,956,000 + 127,296,000

= 923,058,000

Conclusion

Based on the research data, before calculating distribution costs using the North West Corner and Modified Distribution methods, the company must pay a distribution cost of Rp. 963,000,000 in a year. By using the North West Corner method as the initial solution, the total cost obtained is Rp. 928,831,000, and by using the Modified Distribution methods as the optimal solution, the total distribution cost is Rp. 923,058,000. Because the test results show the optimal solution, the allocation has been optimal and can be said to have reached the most profitable value. So that the method used can save costs of Rp. 39,942,000, with a percentage of 4.14%.

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Mathematical model building for pandemic COVID-19 with factor of Applying Restrictions on Community Activities (ARCA)

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Abstract. *Applying Restrictions on Community Activities (ARCA) is one of the policies issued by the Indonesian government aimed at reducing the rate of COVID-19 spread. This policy is very popular among Indonesian people. Besides constructing a mathematical model for the spread of COVID-19 by taking into account the factor of applying restrictions on community activities (ARCA), it also examines the impact of (ARCA) on the dynamics of COVID-19 spread. The mathematical model produces a four-dimensional non-linear differential equation. Through mathematical analysis, two equilibrium points are obtained, namely a disease-free equilibrium point and an endemic equilibrium point. Furthermore, a linearization was carried out using the next generation matrix method to obtain the basic reproduction number (Ro) which is the threshold point for the spread of the COVID-19 disease. By substituting the parameter values obtained from real data into the formula, the value of Ro=1.544 or R0>1 shows that the COVID-19 in Indonesia has not disappeared. The results showed that the disease-free equilibrium point was unstable, while the endemic equilibrium point was asymptotically stable. Simulation results and studies show that the implementation of ARCA can have a significant impact on the spread of COVID-19. The results also show that if ARCA is not enforced, the COVID-19 virus persists in the population and spreads quickly and the value is quite high, The results show that if the total population that complies with ARCA is 60%, then at t=200 COVID-19 will disappear from the system.*

Keywords : COVID-19, ratio reproduction number, ARCA, stability.

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Introduction

At the end of 2019, the world was shocked by the threat of coronavirus disease 2019 (COVID-19) that caused by Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) which was first discovered in the city of Wuhan, China [1-4]. This virus spreads very quickly and has spread to more than 200 countries, so that on March 11, 2020 the World Health Organization (WHO) designated COVID-19 as a global pandemic. Until January 29, 2022, the number of COVID-19 cases in the world reached 366 million cases [5-6]. The COVID-19 virus spreads rapidly which causes many deaths occur through human-to-human infection, both direct and indirect contact. Direct contact, for example through a handshake, and indirect contact, for example through droplets. Indonesia with the 5th largest population in the world cannot be separated from the spread of COVID-19 until January 2022, COVID-19 cases in Indonesia reached 4.5 million cases and 106,241 people died.

The spread of COVID-19 is very fast and the death rate is high enough to be a concern in all circles. No one can predict when the COVID-19 pandemic will end [7]. In humans, COVID-19 causes respiratory tract infections which are generally mild, such as runny nose, cough, fever as well as several forms of the disease such as; SARS, MERS, but COVID-19 is more deadly [8]. With the COVID-19 outbreak in Indonesia causing concern among all groups, especially in society, the government of the Republic of Indonesia has not only remained silent about this spike in COVID-19, the government has immediately taken strategic steps to break the chain of COVID-19, starting to implement 3M (washing hands, wearing masks and keeping distance), PSBB (large-scale social restrictions), administering vaccines, but the COVID-19 pandemic is not over yet. One of the currently popular policies to stop the spread of COVID-19 issued by the Indonesian government is Applying Restrictions on Community Activities (ARCA). Of course ARCA is different from lockdown, ARCA still allows people to travel outside the area on condition that they have been vaccinated and include PCR swab results, while lockdown cannot leave the house and gather, all transportation and office activities, schools and worship places are disabled. Indonesia has never carried out a lockdown but adopted a policy by implementing PPKM. Some literature suggests that the act of carrying out a lockdown is significant for the spread of COVID-19, as has been done by China, this is also evidenced by the results of research which suggests that implementing a lockdown is effective and able to reduce the spread of COVID-19 [9] . From the other side, the implementation of the lockdown has had a negative impact on the economic activities of the community. If the community's economy is disrupted, it will result in even bigger problems. Therefore the Indonesian government did not implement a lockdown but adopted a policy of implementing PPKM.

Applying Restrictions on Community Activities (ARCA) were first implemented on February 9 2021, however, COVID-19 continued to mutate until it gave rise to a new variant called the Delta Variant. It is reported that the delta variant spreads faster than the previous COVID-19. This resulted a spike in COVID-19 cases in several regions of Indonesia.

The phenomenon of COVID-19 spread can be presented in a mathematical model. Mathematical models are powerful tools for simulating and controlling the spread of COVID-19. Through mathematical modeling a complex problem can be described more simply and easily understood [10-11]. One way to prevent disease transmission is to study the behavior of each parameter that influences the spread of the disease, this can be done through a mathematical modeling approach.

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Mathematicians have done a lot of research on the spread of COVID-19 including Archana Sings et al, in 2021 doing research in India by investigating the effect of lockdown, the results show that the implementation of lockdown in India is effective in reducing the rate of spread of COVID-19 [12]. Research on mathematical models with the implementation of lockdown in Nigeria, in this case comparing four methods, namely ODE45, Euler, RK-2 and RK-4 [13]. Research on the effect of vaccines on the spread of COVID-19 resulted in vaccines being able to slow the spread of COVID-19 and suggested that giving vaccines to 70% of the population was able to reduce the number of infections to zero. Mathematical modeling of COVID-19 spread with social distancing factors with SIR based was carried out by [14]. Research using a SSrOPIR mathematical model which describes the spread of COVID-19 in Jakarta by looking at the effectiveness of the PSBB policy on the success of suppressing transmission was carried out by [15].

Mathematical models

The constructed mathematical model consists of a four-dimensional dynamic model with a susceptible subpopulation $S(t)$, ARCA subpopulation $S_p(t)$, Infection subpopulation $I(t)$ and Recovered subpopulation $R(t)$. Assumed constant population, no immigration and emigration. So, the model offered in this study is the SS_pIR model, the total population $N(t)$ is the sum of the four subpopulations. In this case $N(t) = S(t) + S_p(t) + I(t) + R(t)$ and $N(t) = 1$. The susceptible subpopulation increases with a birth rate of π and decreases due to migration to the ARCA subpopulation of θ, with a migration rate of c, moving to an infection subpopulation of $(1-\theta)$ with a migration rate of d and there are natural deaths of μ. The ARCA subpopulation increases with the movement of susceptible subpopulations of θ with a transfer rate of c and decreases with the movement of the infected subpopulation of $(1-\beta)$ with a migration rate of m.

The model equation is given by

$$\frac{ds}{dt} = \pi - (1-\theta)\alpha si - \theta cs - \mu s \quad (1)$$

$$\frac{ds_p}{dt} = \theta cs - \beta d s_p i - (1-\beta) m s_p - \mu s_p \quad (2)$$

$$\frac{di}{dt} = (1-\theta)\alpha si + \beta d s_p i - \gamma i - (\mu + \epsilon) i \quad (3)$$

$$\frac{dr}{dt} = (1-\beta) m s_p + \gamma i - \mu r \quad (4)$$

A schematic flowchart is presented in Figure 1 to understand the dynamics of COVID-19.

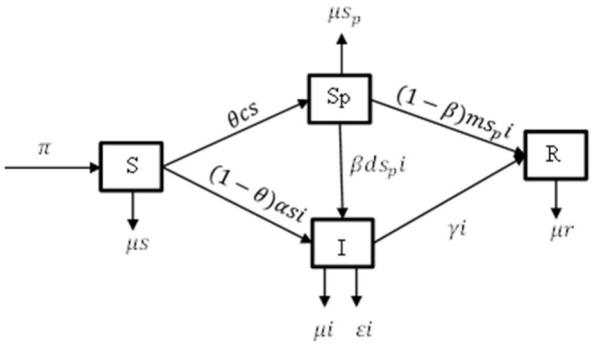


Figure 1. Schematic flow diagram of the SSpIR COVID-19 model

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The initial conditions are $S \geq 0, Sp \geq 0, I \geq 0$ and $R \geq 0$. Parameter descriptions are defined in Table 1.

Table 1. Parameter descriptions

Parameter	Description
$\boldsymbol{\pi}$	Birth rate
$\boldsymbol{\mu}$	Natural death rate
$\boldsymbol{\alpha}$	The movement rate from susceptible individuals to infected individuals
$\boldsymbol{\beta}$	The proportion of ARCA individuals who become infected individuals
$\boldsymbol{d}$	The movement rate from ARCA individuals to infected individuals
$\boldsymbol{m}$	The movement rate from ARCA individuals and not infected to recovered individuals
$\boldsymbol{\gamma}$	The movement rate of infected individuals to recovered individuals
$\boldsymbol{\theta}$	Proportion of susceptible individuals to become ARCA individuals
$\boldsymbol{c}$	The movement rate of susceptible individuals to become individuals who comply with ARCA

Model dynamics with ARCA factors

Equilibrium analysis

In a dynamical system, the equilibrium point is the state of the system that does not change with time. Thus, if the system starts at an equilibrium point, it will remain in equilibrium forever. We are interested in finding the equilibrium state of system when it's free from disease that is, disease free equilibrium point and endemic/pandemic equilibrium state. A system is said to be in equilibrium point if it satisfies:

$$\frac{ds}{dt} = 0, \frac{dsp}{dt} = 0, \frac{di}{dt} = 0, \frac{dr}{dt} = 0 \quad (5)$$

The equilibrium point value for a disease-free condition is when the value $i = 0$, so it is obtained

$$s = \frac{\pi}{c\theta+\mu} \quad (6)$$

$$sp = -\frac{\pi c\theta}{(c\theta+\mu)(-\mu+(\beta-1)m)} \quad (7)$$

$$i = 0 \quad (8)$$

$$r = \frac{(\beta-1)\pi c\theta m}{\mu(c\theta+\mu)(-\mu+(\beta-1)m)} \quad (9)$$

Thus

$$E_0 = (s, sp, i, r) = \left(\frac{\pi}{c\theta+\mu}, -\frac{\pi c\theta}{(c\theta+\mu)(-\mu+(\beta-1)m)}, 0, \frac{(\beta-1)\pi c\theta m}{\mu(c\theta+\mu)(-\mu+(\beta-1)m)}\right) \quad (10)$$

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Endemic equilibrium point $(\boldsymbol{E_0})$

The equilibrium point in endemic conditions is when there are individuals infected with the COVID-19 virus or $i \neq 0$. The endemic equilibrium point obtained is:

$$S = \frac{\left((-\mu m+(-\gamma-\varepsilon)m-d\pi)\beta-\theta\left((m+\gamma+\varepsilon)\mu+m(\gamma+\varepsilon)\right)\right)\alpha-d\mu\beta(\gamma+\varepsilon)-K}{2(\theta-1)\left(-\mu+m(\beta-1)\right)(\theta-1)\alpha+\beta d\mu)\alpha} \quad 11$$

$$Sp = -\frac{\left((-\mu m+(-\gamma-\varepsilon)m+d\pi)\beta-\theta\left((m+\gamma+\varepsilon)\mu+m(\gamma+\varepsilon)\right)\right)\alpha-d\mu\beta(\gamma+\varepsilon)+K}{2\beta d(-(\theta-1)(m\beta-m-\mu)\alpha+d\mu\beta)} \quad 12$$

$$I = \frac{((\theta-1)\left(-\mu+m(\beta-1)\right)\alpha+c\theta\beta d)K+(\theta-1)^2((-\mu+\gamma(n-1)-n\rho-\varepsilon)(\beta-1)m}{((\theta-1)\beta(-K+(\theta-1)((-\mu+\gamma(n-1)-n\rho-\varepsilon)(\beta-1)m+d\pi\beta} \quad 13$$

$$R = -\frac{K}{2d\beta\mu\alpha(\theta-1)(\mu+(-n+1)\gamma+n\rho+\varepsilon)\left(-K(\theta-1)\left(-\mu+m(\beta-1)\right)\alpha+\beta d\mu\right)\alpha(\mu+w)} \quad 14$$

with

$$K = \Big((\theta-1)^2((-m\mu+(\gamma(n-1)-n\rho-\varepsilon)m+d\pi)\beta-(-\mu+\gamma(n-1)-n\rho-\varepsilon)(m+\mu)^2\alpha^2-2(\theta-1)\beta d(-\mu+\gamma(n-1)-n\rho-\varepsilon)\Big(\big((-m\mu+(\gamma(n-1)-n\rho-\varepsilon)m-d\pi)c\theta+(-m\mu+(\gamma(n-1)-n\rho-\varepsilon)m+d\pi)\mu\big)\beta-(-\mu+\gamma(n-1)-n\rho-\varepsilon)(m+\mu)(c\theta+\mu)\Big)\alpha+\beta^2d^2(-\mu+\gamma(n-1)-n\rho-\varepsilon)^2(c\theta+\mu)^2\Big)^{1/2} \quad 15$$

Basic reproduction number

Basic Reproductive Number is a threshold number that determines the number of infections produced by an infected individual during his life or the entire period of his infection in a population where each individual is in a susceptible condition. Determining the basic reproduction number will use the next generation matrix approach. The system of equations used is the equation that causes infection only, namely i. The equation that causes infection:

$$\frac{di}{dt} = (1-\theta)\alpha si + \beta d s_p i - \gamma i - (\mu+\epsilon)i \quad 16$$

Then we get vectors, namely vectors F and V as follows:

$$F = \left[(1-\theta)\alpha si + \beta d s_p i\right] \quad 17$$

$$V = \left[\gamma i + (\mu+\epsilon)i\right] \quad 18$$

Linearization of vector F and vector V is obtained:

$$F = \left[\frac{\partial_{F_1}}{\partial_i}\right] = \left[(1-\theta)\alpha s + \beta d s_p\right] \quad 19$$

$$V = \left[\frac{\partial_{V_1}}{\partial_i}\right] = \left[\gamma+\mu+\epsilon\right] \quad 20$$

Furthermore, the inverse of matrix V is obtained, namely:

$$V = \left[\frac{\partial_{V_1}}{\partial_i}\right]^{-1} \quad 21$$

$$V^{-1} = \left[\frac{1}{\gamma+\mu+\epsilon}\right] \quad 22$$

So that the next generation matrix is obtained as follows

$$K = FV^{-1} = \left[(1-\theta)\alpha s + \beta d s_p\right]\left[\frac{1}{\gamma+\mu+\epsilon}\right] \quad 23$$

$$K = \left[\frac{(1-\theta)\alpha s+\beta d s_p}{\gamma+\mu+\epsilon}\right] \quad 24$$

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Substituting non-endemic equilibrium point values into the K matrix, we get:

$$K = \left[\frac{(1-\theta)\alpha\left(\frac{\pi}{c\theta+\mu}\right)+\beta d\left(-\frac{\pi c\theta}{(c\theta+\mu)(-\mu+(\beta-1)m)}\right)}{\gamma+\mu+\epsilon}\right] \quad 25$$

$$K = -\frac{\pi\left((\theta-1)(m(\beta-1)-\mu)\alpha+c\theta\beta d\right)}{(\gamma+\mu+\epsilon)(c\theta+\mu)(m(\beta-1)-\mu)} \quad 26$$

Eigenvalue of K

$$\lambda_1 = -\frac{\pi\left((\theta-1)(m(\beta-1)-\mu)\alpha+c\theta\beta d\right)}{(\gamma+\mu+\epsilon)(c\theta+\mu)(m(\beta-1)-\mu)} \quad 27$$

Therefore, the basic reproduction number is given by

$$R_0 = -\frac{\pi\left((\theta-1)(m(\beta-1)-\mu)\alpha+c\theta\beta d\right)}{(\gamma+\mu+\epsilon)(c\theta+\mu)(m(\beta-1)-\mu)} \quad 28$$

SSpIQR model stability analysis

The equation is exemplified as follows:

$$f_1 = \pi - (1-\theta)\alpha si - \theta cs - \mu s \quad 29$$

$$f_2 = \theta cs - \beta d s_p i - (1-\beta)m s_p - \mu s_p \quad 30$$

$$f_3 = (1-\theta)\alpha si + \beta d s_p i - \gamma i - (\mu+\epsilon)i \quad 31$$

$$f_4 = (1-\beta)m s_p + \gamma i - \mu r \quad 32$$

Then it is derived from s, s_p, i, r using the Jacobian as follows:

$$J(s, sp, i, r) = \begin{bmatrix} \frac{\partial_{F_1}}{\partial_s} & \frac{\partial_{F_1}}{\partial_{sp}} & \frac{\partial_{F_1}}{\partial_i} & \frac{\partial_{F_1}}{\partial_r} \\ \frac{\partial_{F_2}}{\partial_s} & \frac{\partial_{F_2}}{\partial_{sp}} & \frac{\partial_{F_2}}{\partial_i} & \frac{\partial_{F_2}}{\partial_r} \\ \frac{\partial_{F_3}}{\partial_s} & \frac{\partial_{F_3}}{\partial_{sp}} & \frac{\partial_{F_3}}{\partial_i} & \frac{\partial_{F_3}}{\partial_r} \\ \frac{\partial_{F_4}}{\partial_s} & \frac{\partial_{F_4}}{\partial_{sp}} & \frac{\partial_{F_4}}{\partial_i} & \frac{\partial_{F_4}}{\partial_r} \end{bmatrix} \quad 33$$

So the matrix is obtained as follows:

$$J(s, sp, i, r) = \begin{bmatrix} -(1-\theta)\alpha i - \theta c - \mu & 0 & -(1-\theta)\alpha s & 0 \\ \theta c & -\beta d i - (1-\beta)m - \mu & -\beta d s_p & 0 \\ (1-\theta)\alpha i & \beta d i & (1-\theta)\alpha s + \beta d s_p - \gamma - (\mu+\epsilon) & 0 \\ 0 & (1-\beta)m & \gamma & -\mu \end{bmatrix} \quad 34$$

Analysis of non-endemic stability points $(\boldsymbol{E_0})$

Substitution $E_0 = (s, sp, i, r) = \left(\frac{\pi}{c\theta+\mu}, -\frac{\pi c\theta}{(c\theta+\mu)(-\mu+(\beta-1)m)}, 0, \frac{(\beta-1)\pi c\theta m}{\mu(c\theta+\mu)(-\mu+(\beta-1)m)}\right)$ to matrix $J(s, sp, i, r)$ obtained:

$$J(E_0) = \begin{bmatrix} -\theta c - \mu & 0 & -(1-\theta)\alpha s & 0 \\ \theta c & -(1-\beta)m - \mu & -\beta d s_p & 0 \\ 0 & 0 & (1-\theta)\alpha s + \beta d s_p - \gamma - (\mu+\epsilon) & 0 \\ 0 & (1-\beta)m & \gamma & -\mu \end{bmatrix} \quad 35$$

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Then looking for the eigenvalues of the Jacobian matrix we get:

$$\lambda_1 = -\mu, \quad (36)$$

$$\lambda_2 = -c\theta - \mu, \quad (37)$$

$$\lambda_3 = \beta m - m - \mu, \quad (38)$$

$$\lambda_4 = \frac{\begin{pmatrix}\mu^3+((1-\beta)m+c\theta+\varepsilon+\gamma)\mu^2+(-(\beta-1)(c\theta+\varepsilon+\gamma)m+(c(\varepsilon+\gamma)+\alpha\pi)\theta-\alpha\pi)\mu-(\beta-1)\\((c(\varepsilon+\gamma)+\alpha\pi)\theta-\alpha\pi)m-\beta d\pi\theta c\end{pmatrix}}{(c\theta+\mu)((\beta-1)m-\mu)} \quad (39)$$

The eigenvalues of the Jacobian matrix indicate that three eigenvalues are negative and one is positive ($\boldsymbol{\lambda_4}$). Because one eigenvalue is positive, it can be concluded that the disease-free equilibrium points are unstable (sadle).

Analysis of endemic stability points $(\boldsymbol{E_1})$

Substitution E_1 to matrix $J(s, sp, i, q, r)$ and:

$$S = \frac{\left((-\mu m+(-\gamma-\varepsilon)m-d\pi)\beta-\theta\left((m+\gamma+\varepsilon)\mu+m(\gamma+\varepsilon)\right)\right)\alpha-d\mu\beta(\gamma+\varepsilon)-K}{2(\theta-1)\left(-\mu+m(\beta-1)\right)(\theta-1)\alpha+\beta d\mu)\alpha} \quad (40)$$

$$Sp = -\frac{\left((-\mu m+(-\gamma-\varepsilon)m+d\pi)\beta-\theta\left((m+\gamma+\varepsilon)\mu+m(\gamma+\varepsilon)\right)\right)\alpha-d\mu\beta(\gamma+\varepsilon)+K}{2\beta d(-(\theta-1)(m\beta-m-\mu)\alpha+d\mu\beta)} \quad (41)$$

$$I = \frac{((\theta-1)\left(-\mu+m(\beta-1)\right)\alpha+c\theta\beta d)K+(\theta-1)^2((-\mu+\gamma(n-1)-n\rho-\varepsilon)(\beta-1)m}{((\theta-1)\beta(-K+(\theta-1)((-\mu+\gamma(n-1)-n\rho-\varepsilon)(\beta-1)m+d\pi\beta} \quad (42)$$

$$R = -\frac{K}{2d\beta\mu\alpha(\theta-1)(\mu+(-n+1)\gamma+n\rho+\varepsilon)\left(-K(\theta-1)\left(-\mu+m(\beta-1)\right)\alpha+\beta d\mu\right)\alpha(\mu+w)} \quad (43)$$

Obtained

$$J(E_1) = \begin{bmatrix} -\theta i-\alpha-\mu & 0 & -\theta s & 0 & 0 \\ \alpha & -\beta i-\rho-\mu & -\beta s_p & 0 & 0 \\ \theta i & \beta i & \theta s+\beta s_p-\delta-\varepsilon & 0 & 0 \\ 0 & 0 & \delta & -\gamma-\mu & 0 \\ 0 & \rho & 0 & \gamma & -\mu \end{bmatrix} \quad (44)$$

The eigenvalues of the Jacobian matrix around E_1 show that all tree eigenvalues are negative., but for Thus all equations have roots whose real part is negative, so it can be concluded that the endemic equilibrium point is asymptotically stable.

Simulation

In this section, we discuss the dynamics of the spread of the COVID-19 SSpIR model by paying attention to the implementation of PPKM. Through this simulation, a scenario is shown by giving several variations of the parameter values for the proportion of the displacement of the susceptible subpopulation to the infected subpopulation. Changes in this value variation are associated with dynamics to other subpopulations. Numerical simulations were performed using the MATLAB and MAPLE software. Parameter values used are obtained from real data, literature and some of them are assumed. The following table of Variable values and parameters used for simulation.

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Table 2. Parameter value descriptions

Parameter	Value	Reference
π	0.0162	Real data
μ	0.0162	Real data
α	0.0714	16
β	0.002	Assumed
d	0.003	Assumed
m	0.7	Assumed
γ	0.057	17
θ	0.4	Assumed
c	0.04	18
S(0)	0.98663	Real Data
I(0)	0.00678	Real Data
Sp(0)	0.00329	Assumed
R(0)	0.00160	Assumed

1. Simulation for Ro < 1

The condition R0 < 1 is also called disease-free condition where the number of infected population does not exist (I=0). In this condition the values of S, Sp and R exist but the value of i = 0, the simulation results for this condition is:

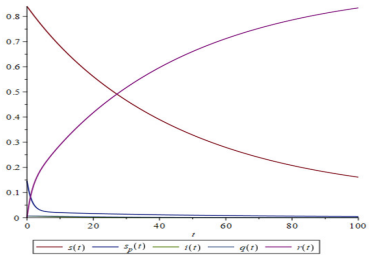


Figure 2. Graph of the dynamics of the spread of COVID-19 with R0 < 1

In Graph 5.1 with R0 < 1, it shows that no individual is infected with COVID-19 (I=0), this condition is also called disease-free equilibrium. In this condition, the Susceptible sub-population initially has a value of one, with increasing time the Susceptible sub-population decreases towards zero, on the other hand, the Recover sub-population is initially at the same point and its value is zero, with increasing time these two sub-populations increase in value. a decrease in the susceptible subpopulation and an increase in the value of the cured subpopulation indicate instability, in this case the disease-free equilibrium point is unstable (saddle point).

2. Simulation for Ro > 1

This condition indicates that there are already infected individuals and are ready to infect other individuals (i≠0). In this scenario, it is assumed that none of the individuals comply with the ARCA, which means that all individuals are free to do activities outside the home. The values of the variables and parameters used are as listed in Table 2. By substituting the parameter values in

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table 2. to the basic reproduction number formula, we get the value Ro = 1.544 (Ro > 1), Through Maple software, the simulation results are in the form of a graph as below.

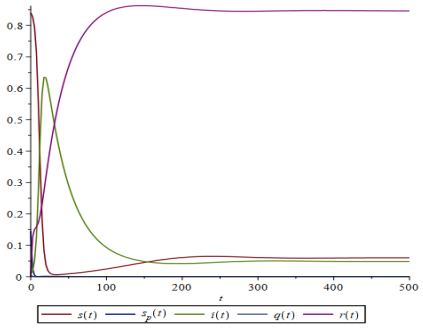


Figure 3. Graph of the dynamics of the spread of COVID-19 with R0 >1 ($\theta = 0$)

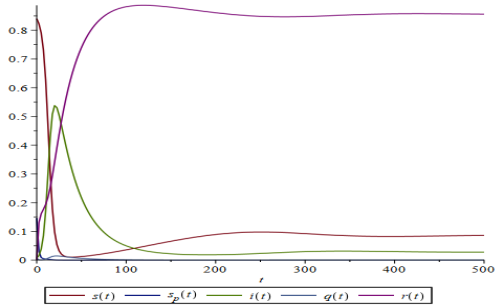


Figure 4. Graph of the dynamics of the spread of COVID-19 with R0 >1 ($\theta = 10\%$)

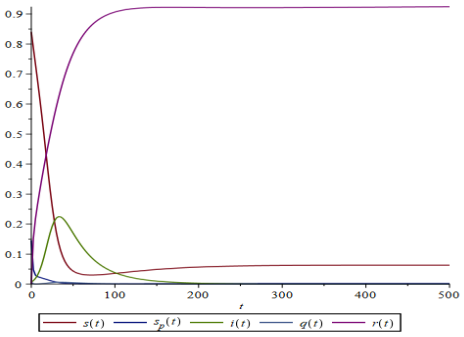


Figure 5. Graph of the dynamics of the spread of COVID-19 with R0 >1 ($\theta = 40\%$)

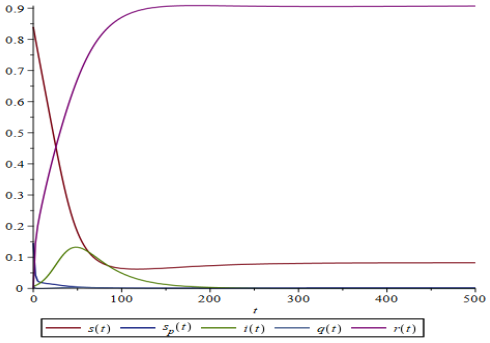


Figure 6. Graph of the Dynamics of the Spread of COVID-19 with R0 >1 ($\theta = 60\%$)

The four graphic images above are the results of simulations with the condition $R_0 > 1$ by substituting variations value of the movement proportion of susceptible subpopulations to ARCA subpopulations (θ). Figure 3 is a simulation image for $\boldsymbol{\theta = 0}$. In this graph, it is assumed that there are no individuals who comply with ARCA, both infected and susceptible. From the figure it is clear that the susceptible sub-population in the initial conditions has a peak value close to 1, as time goes on the susceptible subpopulation moves to the ARCA subpopulation and the infected subpopulation, this condition can be seen from the graph which drops drastically then the graph is constant or stable, the stability point in the susceptible subpopulation is around the coordinates (300;0.05). Because ARCA has not been implemented, the spread of COVID-19 is quite high and reaches a maximum point close to 0.65, meaning that if ARCA is not implemented in condition$R_0 > 1$s, then 65% of the number of susceptible individuals will turn into infected individuals.

In Figure 4 is the simulation for for $\theta = 10\%$, in this case 10% of the total population has already implemented ARCA. The graph shows a change in the dynamics of the spread of COVID-19 in each subpopulation, especially in the infected subpopulation, where with a value of $\theta = 10\%$, the number of infected individuals decreased from 65% to 53%. Figure 5 assumes that the proportion of movement of susceptible individuals to the ARCA subpopulation is 40% ($\boldsymbol{\theta = 40\%}$), the simulation results show that there is a significant decrease in the number of

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infected populations, the highest rate in this condition is 23%. Furthermore, in Figure 6. it is assumed that the proportion of movement of susceptible individuals to the ARCA subpopulation is 60%, ($\boldsymbol{\theta = 60\%}$), the graph of the simulation results shows that the number of infected individuals decreases, the highest rate in this condition drops to 15% and the graph also shows that if 60% of the total vulnerable population follows ARCA so COVID-19 can disappear from the system. From the results of the study it can be concluded that the application of ARCA rules has a significant effect on the spread of COVID-19.

Conclusion

From the results of the study, two equilibrium points were obtained, namely a disease-free equilibrium point and an endemic equilibrium point. At the disease-free equilibrium point it shows instability (sadle) and at the endemic equilibrium point it is asymptotically stable. Substituting parameter values in the Basic Reproductive Number formula (R_0) obtained a value of $R_0 > 1$ ($R_0 = 1.544$). This condition indicates that COVID-19 in Indonesia has not disappeared from the system, there is still a possibility of becoming a pandemic. Applying the rules for limiting the movement of community activities (ARCA) has a significant effect on reducing the rate of spread of COVID-19. The larger the population that follows the ARCA rules, the number of infected individuals will decrease, even from the simulation results if 60% of the total population follows ARCA then the virus COVID-19 can disappear from the system.

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Determinants of non-square matrices

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Abstract. *In the development of matrices, mathematicians are only interested in finding the value of the determinant for a square matrix. The concept of the determinant, as it is known, its definition, properties and application are only for square matrices. The formal definition in interpreting the determinant as the difference of the product of the diagonals of a square matrix, it will be a problem when looking for the determinant of a non-square matrix. Mirko Radic in 2005 who discovered the concept of determinants for non-square matrices known as the Radic method. In general, the determinant properties of square matrices can be generalized to non-square matrices*.

Keywords: non-square matrix, diagonal matrix, radic method.

Introduction

A matrix is a collection of numbers, both real and complex, which are arranged or aligned rectangularly according to rows and columns. With matrix representation, calculations can be carried out in a more structured manner, for example in explaining linear equations, linear transformations, and others. From any square matrix, we can calculate the determinant of the matrix. The determinant of a matrix is all the elementary products of the

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matrix. The application of the determinant is used to determine the inverse of a matrix, determine the solution of a system of linear equations, determine the characteristic equation of any matrix and others. The properties of the determinants of square matrices have been widely studied. However, research that examines the determinants and properties of non-square matrix determinants is still relatively rare.

Based on the results of a literature search, research related to determinants for non-square matrices has been carried out by Radic [1], which discusses the determinants of $2xn$ matrices and their interpretation in geometry. Further research was carried out by Amiri [2], which discussed the Radic determinant for a non-square matrix and the properties of the determinant for the non-square matrix. Makarewicz [3], investigated a new identity for the Radic determinant of a non-square matrix.

The calculation of the determinant of a square matrix can be done in various ways, including the Sarrus method, the cofactor expansion method, the Chio method, the Dodgson method and the Gauss elimination method. However, the calculation of determinants of non-square matrisks so far has only been carried out using the Radic method and cofactor expansion.

This paper discusses some of the determinant properties of non-square matrices using the definition proposed by Radic. The properties of these determinants are generalizations of the properties of the determinants of a square matrix.

Determinant

Before further discussion, it is necessary to know the definitions which are important in calculating the determinant of the matrix as stated in the following definition.

Definition 1

A permutation of the set of positive integers $S = \{1,2,3,\cdots,n\}$ is a bijective function from S to S.

Definition 2

A permutation is called an even permutation if the number of inversions in the permutation is even. On the other hand, a permutation is called an odd permutation if the number of inversions in the permutation is odd.

Definition 3

Let's say matrix $A = (a_{ij})$ size nxn. The determinant of the matrix $A = (a_{ij})$ is denoted by $|A|$ or $\det(A)$ and is defined as

$$\det(A) = \sum(\pm)a_{1j_1}a_{2j_2}\cdots a_{nj_n}$$

where $j_1, j_2, \cdots, j_n$ are all permutations of $S = \{1,2,3,\cdots,n\}$. The $\pm$ sign depends on whether the permutation is even or odd.

Determinant properties of a square matrix

The properties of the determinants of a square matrix are stated in the following theorems:

Theorem 1

If A is a square matrix of size nxn that has rows or columns whose elements are zero, then $\det(A) = 0$.

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Theorem 2

If matrix B is obtained from matrix A by multiplying one of the rows of matrix A by the number $k \neq 0$ then $\det(B) = k.\det(A)$.

Theorem 3

If k is a constant and A is a square matrix of size nxn then $\det(kA) = k^n \det(A)$.

Theorema 4

If two rows or two columns in a square matrix are identical, then the determinant is zero.

Theorema 5

The interchange of two rows or columns of a square matrix will not change the absolute value of its determinant but change its positive negative form.

Theorem 6

The determinant of the product of two matrices of order n is the same as the product of their respective determinants of the matrix. In other word $\det(AB) = \det(A)\det(B)$.

Theorema 7

A square matrix A can be inverted (has an inverse) if $\det(A) \neq 0$.

Proof:

If A is reversible then $AA^{-1} = I$. If we take the determinant, then

$$\det(AA^{-1}) = \det(I) = 1 \quad \text{(i)}$$

According to Theorem 6,

$$\det(AA^{-1}) = \det(A)\det(A^{-1}) \quad \text{(ii)}$$

From (i) and (ii) it is obtained, $(\det A)(\det A^{-1}) = 1$, thus $\det A \neq 0$.

Research results

The calculation of the determinant of a non-square matrix is usually carried out using the method that has been carried out by Radic. In this paper, we generalize the calculation of these determinants from the cofactor expansion which is commonly used for square matrices. The results obtained are presented in several theorems.

Definition 1

Let $B = (b_{ij})$ be a matrix of size mxn with $m \leq n$. The determinant of matrix B is defined as follows

$$\det(B) = \sum_{i \leq j_1 < \cdots j_m \leq n} (-1)^{r+s} \det \begin{bmatrix} b_{1j_1} & \cdots & b_{1j_m} \\ \vdots & \ddots & \vdots \\ b_{mj_1} & \cdots & b_{mj_m} \end{bmatrix}$$

where $j_1, j_2, \cdots, j_m \in N, r = 1+2+\cdots+m$ and $s = j_1 + j_2 + \cdots + j_m$.

If $m > n$, then $\det(B) = \det(B^T)$.

The determinant of a non-square matrix has several properties, as stated in the following theorems.

Theorem 1

Let B be any non-square matrix mxn with $m \leq n$. If the row of matrix B is a linear combination of the other rows, then $\det(B) = 0$.

Proof:

Let B be a matrix mxn with $m \leq n$, by definition Radic

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$$\det(B) = \sum_{i \le j_1 < \cdots j_m \le n} (-1)^{r+s} \det \begin{bmatrix} b_{1j_1} & \cdots & b_{1j_m} \\ \vdots & \ddots & \vdots \\ b_{mj_1} & \cdots & b_{mj_m} \end{bmatrix}$$

where $j_1, j_2, \cdots, j_m \in N, r = 1+2+\cdots+m$ and $s = j_1 + j_2 + \cdots + j_m$.

If the rows of matrix B are linear combinations of several other rows, then all $\det \begin{bmatrix} b_{1j_1} & \cdots & b_{1j_m} \\ \vdots & \ddots & \vdots \\ b_{mj_1} & \cdots & b_{mj_m} \end{bmatrix}$ load a linear combination row on some other row, and therefore all $\det \begin{bmatrix} b_{1j_1} & \cdots & b_{1j_m} \\ \vdots & \ddots & \vdots \\ b_{mj_1} & \cdots & b_{mj_m} \end{bmatrix} = 0$, where $j_1, j_2, \cdots, j_m \in N$, is a square matrix, therefore $\det(B) = 0$

Take a look at the following matrix $A = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 2 & 1 & 3 & 4 \\ 4 & 3 & 5 & 6 \end{bmatrix}$. Based on Definition 3.1, then

$$\det(A) = (-1)^{(1+2+3)+(1+2+3)} \det \begin{bmatrix} 1 & 1 & 1 \\ 2 & 1 & 3 \\ 4 & 3 & 5 \end{bmatrix} + (-1)^{(1+2+3)+(1+2+4)} \det \begin{bmatrix} 1 & 1 & 1 \\ 2 & 1 & 4 \\ 4 & 3 & 6 \end{bmatrix}$$

$$+(-1)^{(1+2+3)+(1+3+4)} \det \begin{bmatrix} 1 & 1 & 1 \\ 2 & 3 & 4 \\ 4 & 5 & 6 \end{bmatrix} + (-1)^{(1+2+3)+(2+3+4)} \det \begin{bmatrix} 1 & 1 & 1 \\ 1 & 3 & 4 \\ 3 & 5 & 6 \end{bmatrix}$$

$$= \det \begin{bmatrix} 1 & 1 & 1 \\ 2 & 1 & 3 \\ 4 & 3 & 5 \end{bmatrix} - \det \begin{bmatrix} 1 & 1 & 1 \\ 2 & 1 & 4 \\ 4 & 3 & 6 \end{bmatrix} + \det \begin{bmatrix} 1 & 1 & 1 \\ 2 & 3 & 4 \\ 4 & 5 & 6 \end{bmatrix} - \det \begin{bmatrix} 1 & 1 & 1 \\ 1 & 3 & 4 \\ 3 & 5 & 6 \end{bmatrix}$$

$$= 0 - 0 + 0 - 0 = 0$$

Theorem 2

If matrix C is obtained from matrix B by multiplying one of the rows of matrix B by the number $k \neq 0$ then $\det(C) = k.det(B)$.

Proof:

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Let $B=\begin{bmatrix} b_{11} & b_{12} & \cdots & b_{1n} \\ \vdots & \vdots & \ddots & \vdots \\ b_{i1} & b_{i2} & \cdots & b_{in} \\ \vdots & \vdots & \ddots & \vdots \\ b_{m1} & b_{m2} & \cdots & b_{mn} \end{bmatrix}$, and matrix C is obtained from B which is obtained by multiplying the ith row of matrix B by k, $k \neq 0$ that is, $C=\begin{bmatrix} b_{11} & b_{12} & \cdots & b_{1n} \\ \vdots & \vdots & \ddots & \vdots \\ kb_{i1} & kb_{i2} & \cdots & kb_{in} \\ \vdots & \vdots & \ddots & \vdots \\ b_{m1} & b_{m2} & \cdots & b_{mn} \end{bmatrix}$, then

$\det(C)=\sum_{i\le j_1<\cdots j_m\le n}(-1)^{r+s}\det\begin{bmatrix} b_{1j_1} & b_{1j_2} & \cdots & b_{1j_m} \\ \vdots & \vdots & \ddots & \vdots \\ kb_{ij_1} & kb_{ij_2} & \cdots & kb_{ij_m} \\ \vdots & \vdots & \ddots & \vdots \\ b_{mj_1} & b_{mj_2} & \cdots & b_{mj_m} \end{bmatrix}$, so that all

$\det\begin{bmatrix} b_{1j_1} & b_{1j_2} & \cdots & b_{1j_m} \\ \vdots & \vdots & \ddots & \vdots \\ kb_{ij_1} & kb_{ij_2} & \cdots & kb_{ij_m} \\ \vdots & \vdots & \ddots & \vdots \\ b_{mj_1} & b_{mj_2} & \cdots & b_{mj_m} \end{bmatrix}$ where $j_1, j_2, \cdots, j_m \in N$, is a square matrix. This results in

$\det\begin{bmatrix} b_{1j_1} & b_{1j_2} & \cdots & b_{1j_m} \\ \vdots & \vdots & \ddots & \vdots \\ kb_{ij_1} & kb_{ij_2} & \cdots & kb_{ij_m} \\ \vdots & \vdots & \ddots & \vdots \\ b_{mj_1} & b_{mj_2} & \cdots & b_{mj_m} \end{bmatrix}=k\ \det\begin{bmatrix} b_{1j_1} & b_{1j_2} & \cdots & b_{1j_m} \\ \vdots & \vdots & \ddots & \vdots \\ b_{ij_1} & b_{ij_2} & \cdots & b_{ij_m} \\ \vdots & \vdots & \ddots & \vdots \\ b_{mj_1} & b_{mj_2} & \cdots & b_{mj_m} \end{bmatrix}=kdet(B), j_1, j_2, \cdots, j_m \in N$. So it's proven $\det(C)=k\det(B)$.

Take a look at the following matrix $A=\begin{bmatrix}2 & 3 & 1\\ 4 & -4 & 3\end{bmatrix}$.and $B=\begin{bmatrix}2 & 3 & 1\\ 8 & -8 & 6\end{bmatrix}$. Based on Definition 3.1, obtained

$$\det(A)=(-1)^{(1+2)+(1+2)}\det\begin{bmatrix}2 & 3\\ 4 & -4\end{bmatrix}+(-1)^{(1+2)+(1+3)}\det\begin{bmatrix}2 & 1\\ 4 & 3\end{bmatrix}$$

$$+(-1)^{(1+2)+(2+3)}\det\begin{bmatrix}3 & 1\\ -4 & 3\end{bmatrix}=-20-2+13=-9.$$

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Whereas $\det(B) = (-1)^{(1+2)+(1+2)} \det\begin{bmatrix} 2 & 3 \\ 8 & -8 \end{bmatrix} + (-1)^{(1+2)+(1+3)} \det\begin{bmatrix} 2 & 1 \\ 8 & 6 \end{bmatrix}$

$$+(-1)^{(1+2)+(2+3)} \det\begin{bmatrix} 3 & 1 \\ -8 & 6 \end{bmatrix}$$

$$\det(B) = -40 - 4 + 26 = -18 = 2(-9) = 2.\det(A).$$

Based on the above calculations, the calculation of the $2xn$ matrix can be stated as follows:

$$det\begin{bmatrix} a_1 & a_2 & \cdots & a_n \\ b_1 & b_2 & \cdots & b_n \end{bmatrix} = \sum_{1\le i<j\le n}(-1)^{(1+2)+(i+j)} \begin{vmatrix} a_i & a_j \\ b_i & b_j \end{vmatrix}.$$

Theorem 3

If matrix B is obtained from matrix C by exchanging two rows, then $\det(C) = -\det(B)$.

Proof:

Let $B = \begin{bmatrix} b_{11} & b_{12} & \cdots & b_{1n} \\ \vdots & \vdots & \ddots & \vdots \\ b_{r1} & b_{r2} & \cdots & b_{rn} \\ \vdots & \vdots & \ddots & \vdots \\ b_{s1} & b_{s2} & \cdots & b_{sn} \\ \vdots & \vdots & \ddots & \vdots \\ b_{m1} & b_{m2} & \cdots & b_{mn} \end{bmatrix}$ and let C be the matrix derived from the interchange of two rows in matrix B, i.e $C = \begin{bmatrix} b_{11} & b_{12} & \cdots & b_{1n} \\ \vdots & \vdots & \ddots & \vdots \\ b_{s1} & b_{s2} & \cdots & b_{sn} \\ \vdots & \vdots & \ddots & \vdots \\ b_{r1} & b_{r2} & \cdots & b_{rn} \\ \vdots & \vdots & \ddots & \vdots \\ b_{m1} & b_{m2} & \cdots & b_{mn} \end{bmatrix}$, then $\det(C) = \sum_{i\le j_1<\cdots j_m\le n} (-1)^{r+s}$

$\det\begin{bmatrix} b_{1j_1} & b_{1j_2} & \cdots & b_{1j_m} \\ \vdots & \vdots & \ddots & \vdots \\ b_{sj_1} & b_{sj_2} & \cdots & b_{sj_m} \\ \vdots & \vdots & \ddots & \vdots \\ b_{rj_1} & b_{rj_2} & \cdots & b_{rj_m} \\ \vdots & \vdots & \ddots & \vdots \\ b_{mj_1} & b_{mj_2} & \cdots & b_{mj_m} \end{bmatrix}$, so that all $\det\begin{bmatrix} b_{1j_1} & b_{1j_2} & \cdots & b_{1j_m} \\ \vdots & \vdots & \ddots & \vdots \\ b_{sj_1} & b_{sj_2} & \cdots & b_{sj_m} \\ \vdots & \vdots & \ddots & \vdots \\ b_{rj_1} & b_{rj_2} & \cdots & b_{rj_m} \\ \vdots & \vdots & \ddots & \vdots \\ b_{mj_1} & b_{mj_2} & \cdots & b_{mj_m} \end{bmatrix}$ where $j_1, j_2, \cdots, j_m \in N$, is a

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square matrix, then $\det\begin{bmatrix} b_{1j_1} & b_{1j_2} & \cdots & b_{1j_m} \\ \vdots & \vdots & \ddots & \vdots \\ b_{sj_1} & b_{sj_2} & \cdots & b_{sj_m} \\ \vdots & \vdots & \ddots & \vdots \\ b_{rj_1} & b_{rj_2} & \cdots & b_{rj_m} \\ \vdots & \vdots & \ddots & \vdots \\ b_{mj_1} & b_{mj_2} & \cdots & b_{mj_m} \end{bmatrix} = -\det\begin{bmatrix} b_{1j_1} & b_{1j_2} & \cdots & b_{1j_m} \\ \vdots & \vdots & \ddots & \vdots \\ b_{rj_1} & b_{rj_2} & \cdots & b_{rj_m} \\ \vdots & \vdots & \ddots & \vdots \\ b_{sj_1} & b_{sj_2} & \cdots & b_{sj_m} \\ \vdots & \vdots & \ddots & \vdots \\ b_{mj_1} & b_{mj_2} & \cdots & b_{mj_m} \end{bmatrix}$,

$j_1, j_2, \cdots, j_m \in N$, so it is proven that $\det(B) = -\det(A)$.

Take a look at the following matrix : $P = \begin{bmatrix} 1 & 3 & 4 \\ -2 & 4 & 8 \end{bmatrix}$ and $Q = \begin{bmatrix} -2 & 4 & 8 \\ 1 & 3 & 4 \end{bmatrix}$.

$$\det(P) = (-1)^{(1+2)+(1+2)} \det\begin{bmatrix} 1 & 3 \\ -2 & 4 \end{bmatrix} + (-1)^{(1+2)+(1+3)} \det\begin{bmatrix} 1 & 4 \\ -2 & 8 \end{bmatrix} + (-1)^{(1+2)+(2+3)} \begin{bmatrix} 3 & 4 \\ 4 & 8 \end{bmatrix}$$

$$\det(P) = 10 - 16 + 8 = 2.$$

Whereas $\det(Q) = (-1)^{(1+2)+(1+2)} \det\begin{bmatrix} -2 & 4 \\ 1 & 3 \end{bmatrix} + (-1)^{(1+2)+(1+3)} \det\begin{bmatrix} -2 & 8 \\ 1 & 4 \end{bmatrix} + (-1)^{(1+2)+(2+3)} \begin{bmatrix} 4 & 8 \\ 3 & 4 \end{bmatrix}$

$$\det(Q) = -10 + 16 - 8 = -2 = -\det(P).$$

Theorem 4

If matrix B has two identical rows, then $\det(B) = 0$.

Proof:

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Let $B=\begin{bmatrix} b_{11} & b_{12} & \cdots & b_{1n} \\ \vdots & \vdots & \ddots & \vdots \\ b_{r1} & b_{r2} & \cdots & b_{rn} \\ \vdots & \vdots & \ddots & \vdots \\ b_{r1} & b_{r2} & \cdots & b_{rn} \\ \vdots & \vdots & \ddots & \vdots \\ b_{m1} & b_{m2} & \cdots & b_{mn} \end{bmatrix}$, maka $\det(B)=\sum_{i\le j_1<\cdots j_m\le n}(-1)^{r+s}\det\begin{bmatrix} b_{1j_1} & b_{1j_2} & \cdots & b_{1j_m} \\ \vdots & \vdots & \ddots & \vdots \\ b_{rj_1} & b_{rj_2} & \cdots & b_{rj_m} \\ \vdots & \vdots & \ddots & \vdots \\ b_{rj_1} & b_{rj_2} & \cdots & b_{rj_m} \\ \vdots & \vdots & \ddots & \vdots \\ b_{mj_1} & b_{mj_2} & \cdots & b_{mj_m} \end{bmatrix}$.

Since all $\det\begin{bmatrix} b_{1j_1} & b_{1j_2} & \cdots & b_{1j_m} \\ \vdots & \vdots & \ddots & \vdots \\ b_{rj_1} & b_{rj_2} & \cdots & b_{rj_m} \\ \vdots & \vdots & \ddots & \vdots \\ b_{rj_1} & b_{rj_2} & \cdots & b_{rj_m} \\ \vdots & \vdots & \ddots & \vdots \\ b_{mj_1} & b_{mj_2} & \cdots & b_{mj_m} \end{bmatrix}$ where $j_1, j_2, \cdots, j_m \in N$, are square matrices, then all $\det\begin{bmatrix} b_{1j_1} & b_{1j_2} & \cdots & b_{1j_m} \\ \vdots & \vdots & \ddots & \vdots \\ b_{rj_1} & b_{rj_2} & \cdots & b_{rj_m} \\ \vdots & \vdots & \ddots & \vdots \\ b_{rj_1} & b_{rj_2} & \cdots & b_{rj_m} \\ \vdots & \vdots & \ddots & \vdots \\ b_{mj_1} & b_{mj_2} & \cdots & b_{mj_m} \end{bmatrix} = 0$, hence $\det(B) = 0$.

Conclusion

Based on the results of the discussion, the properties of the determinants of the square matrix can be calculated generalize to the determinant of a non-square matrix. For a matrix of order $2xn$, the Radic method can be expressed by

$$det\begin{bmatrix} a_1 & a_2 & \cdots & a_n \\ b_1 & b_2 & \cdots & b_n \end{bmatrix} = \sum_{1\le i<j\le n}(-1)^{(1+2)+(i+j)}\begin{vmatrix} a_i & a_j \\ b_i & b_j \end{vmatrix}$$

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Optimal control model for biological wastewater treatment in facultative stabilization pond

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Abstract. *Wastewater is water that has been contaminated and cannot be reused for daily life. One of the method that can be used to make the water can be reused again is to do the wastewater treatment, either biologically or using some chemicals. This study will discuss the biological treatment of wastewater in the facultative stabilization pond. Biological wastewater treatment can reduce organic matter and remove pathogens to a level that complies with water quality standards. The purpose of this article is to develop a three-variable non-linear dynamic system model that shows the relationship between bacterial concentration, dissolved oxygen concentration and organic matter concentration or BOD (Biological Oxygen Demand) concentration with doing control to the aerator. This non-linear dynamic system model also shows the inflow and outflow of water during the water treatment process and it is can also be called as the optimal control model. Model control and control solutions are discussed in this article. Pontryagin's minimum principle method is used to find the optimal control equation. Numerical simulations were carried out using computational calculations and visualizations with the help of Maple and Matlab.*

Keyword: Wastewater Treatment, Facultative Stabilization Pond, Optimal Control, System of Nonlinear Differensial Equation

Introduction

One of the environmental problems facing the world today is the problem of water pollution. Water pollution occurs because the water that has been used is mixed with harmful substances so that the water cannot be reused. however, a lot of research has been done with the aim of making the wastewater reusable. one of them uses a stabilization pool.

Wastewater treatment with stabilization ponds is carried out by utilizing natural processes between organisms in the pond. Although utilizing natural processes, waste stabilization ponds are also not spared by the use of technology, namely aerators to add oxygen to the pond. The use of aerators in ponds results in very high electricity consumption. Therefore, this article will discuss how control modeling is carried out to minimize electrical energy for the use of aerators.

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Previous research has carried out modeling the relationship between organisms in ponds [1][2][3]. then modeling with control to minimize the waiting time of water in the pond has been carried out by [4][5]. research has also been carried out by [6][7] to minimize the cost of using electricity and minimize energy loss.

This article will discuss the optimum control to minimize the use of electrical energy in the aerator with predetermined limits.

WWTP process and model

Process

In wastewater treatment ponds there are usually three types of ponds. The first is the anaerobic ponds, the second is the aerobic ponds and the last is the maturation ponds. As the name suggests an aerobic pool is a pool where all aerobic microorganisms can interact with each other. Besides that it is in this pond that the aeration process using an aerator is carried out. The basic control strategy given to WWTP ponds is to control the value of the oxygen transfer coefficient (K_L) because this parameter is directly related to air flow [6]. although we cannot directly manipulate the K_L value, we can determine it by adjusting the airflow and relating it to the O (Dissolved Oxygen) value [6].

Modelling

Many mathematical models of wastewater treatment with WWTP have been developed. One of them has been done by [1][2] which uses the ASM1 (Active Sludge Model) base model by Henze et al. [8] which is commonly used. Research has also been carried out by adding the inflow and outflow of water in the pond [9]. In this study, we basically developed a dynamic model of the three existing component variables [9] to serve as state variables whose formation uses the basic ASM1 model by considering the mass balance equation.

The mass balance equation of a component Z is

$$\frac{dZ}{dt} = \frac{Q}{\theta}(Z_{in} - Z) + r_Z \tag{1}$$

Here, the flow rate is Q, the ponds volume is θ, the consentration of component Z in inlet is Z_{in} and the sum of all process that happend in the ponds is r_Z. So beacause in this paper we use three variabel component that is O (Dissolved Oxygen), M (Organic Matter) dan N (Microorganism) so the model of sytem differensial equation in WWTP can be write as

$$\begin{cases} \dfrac{dO}{dt} = -aY_N\mu_N \dfrac{M(t)}{K_M + M(t)} \dfrac{O(t)}{K_O + O(t)} N(t) + K_L(O^{sat} - O(t)) \\ \qquad\qquad + \dfrac{Q}{\theta}(O_{in} - O(t)) \\ \dfrac{dM}{dt} = -\mu_N \dfrac{M(t)}{K_M + M(t)} \dfrac{O(t)}{K_O + O(t)} N(t) + \dfrac{Q}{\theta}(M_{in} - M(t)) \\ \dfrac{dB}{dt} = Y_N\mu_N \dfrac{M(t)}{K_M + M(t)} \dfrac{O(t)}{K_O + O(t)} N(t) - k_N N(t) + \dfrac{Q}{\theta}(N_{in} - N(t)) \\ O(0) = O_0, \quad M(0) = M_0, \quad N(0) = N_0, \\ O_0 = (0, O^{sat}), \quad M_0 > 0, \quad N_0 > 0. \end{cases} \tag{2}$$

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Control strategy for aeration process

Based on the mathematical model equation (2), we use one control variable, namely K_L. All variables O, M, N in equation (2) are functions of time t. The constraints in this optimal control is

(1) The final value of $M(t)$ and $N(t)$ is the same as the initial value so if the water quality and volume water change periodically, the control and state variabel also change periodically. It's can be write as $M(0) = M(T), N(0) = N(T)$ with T is the final time.

(2) Limit K_L to be within a reasonable range. K_L according to the aerator in the ponds. In this paper we use the value of OTR (oxygen transfer rate) 0 to 2.0 kg O2h^{-1}.

Optimization problem

The objective function of our research is to minimize the consumption of electrical energy when using aerators. AE (Aeration Energy) can be defined as:

$$AE = \frac{O^{sat}}{2000T}\int_0^T \theta K_L{}^2(t)dt \tag{3}$$

Where T is duration of evaluation.

To summarize, the optimization problem can be write as:

$$\min_{K_L} J = AE = \frac{O^{sat}}{2000T}\int_0^T \theta K_L{}^2(t)dt$$

State variable

$$\frac{dO}{dt} = -aY_N\mu_N \frac{M(t)}{K_M + M(t)}\frac{O(t)}{K_O + O(t)}N(t) + K_L(O^{sat} - O(t)) + \frac{Q}{\theta}(O_{in} - O(t))$$

$$\frac{dM}{dt} = -\mu_N \frac{M(t)}{K_M + M(t)}\frac{O(t)}{K_O + O(t)}N(t) + \frac{Q}{\theta}(M_{in} - M(t))$$

$$\frac{dB}{dt} = Y_N\mu_N \frac{M(t)}{K_M + M(t)}\frac{O(t)}{K_O + O(t)}N(t) - k_N N(t) + \frac{Q}{\theta}(N_{in} - N(t))$$

With the condition of $M(0) = M(T)$, S(0) = S(T), 0<O(t)<O^{sat}, $0 \le K_L \le \frac{2000}{VO^{sat}}$.

Result and discussion

Hamiltonian

There are many methods that can be used to solve the optimal control problem. One way is to use the Pontryagin Minimum Principle method. To use this method, it is first necessary to construct a Hamiltonian model. So, the Hamilton equation of the above problem is

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$$H = \frac{O^{sat}}{2000T}\theta K_L^{\,2}(t) + p1(t)\left(\begin{array}{l} -aY_N\mu_N \dfrac{M(t)}{K_M + M(t)}\dfrac{O(t)}{K_O + O(t)}N(t) + K_L(O^{sat} - O(t)) \\ \qquad + \dfrac{Q}{\theta}(O_{in} - O(t)) \end{array}\right)$$
$$+p2(t)\left(-\mu_N \frac{M(t)}{K_M + M(t)}\frac{O(t)}{K_O + O(t)}N(t) + \frac{Q}{\theta}(M_{in} - M(t))\right) \quad (4)$$
$$+p3(t)\left(Y_N\mu_N \frac{M(t)}{K_M + M(t)}\frac{O(t)}{K_O + O(t)}N(t) - k_N N(t) + \frac{Q}{\theta}(N_{in} - N(t))\right)$$

Result

After obtaining the Hamiltonian equation, then it is necessary to find the Adjoint variables from the model that can be obtained from searching for the equation of $-\frac{\partial H}{\partial G} = \frac{dG}{dt}$ where $G = \{O, M, N\}$.

So we can write the adjoint variabel of model are

$$\frac{dp_1}{dt} = p_1\left(aY_N\mu_N \frac{M(t)N(t)}{(K_M + M(t))(K_O + O(t))}\left(1 - \frac{O(t)}{(K_O + O(t))}\right) + K_L(t) + \frac{Q}{\theta}\right)$$
$$+p_2\left(\mu_N \frac{M(t)N(t)}{(K_M + M(t))(K_O + O(t))}\left(1 - \frac{O(t)}{(K_O + O(t))}\right)\right) + p_3\left(Y_N\mu_N \frac{M(t)N(t)}{(K_M + M(t))(K_O + O(t))}\left(\frac{O(t)}{(K_O + O(t))} - 1\right)\right)$$

$$\frac{dp_2}{dt} = p_1\left(aY_N\mu_N \frac{O(t)N(t)}{(K_M + M(t))(K_O + O(t))}\left(1 - \frac{M(t)}{(K_M + M(t))}\right)\right)$$
$$+ p_2\left(\mu_N \frac{O(t)N(t)}{(K_M + M(t))(K_O + O(t))}\left(1 - \frac{M(t)}{(K_M + M(t))}\right) + \frac{Q}{\theta}\right)$$
$$+ p_3\left(Y_N\mu_N \frac{O(t)N(t)}{(K_M + M(t))(K_O + O(t))}\left(\frac{M(t)}{(K_M + M(t))} - 1\right)\right)$$

$$\frac{dp_3}{dt} = \mu_N \frac{M(t)O(t)}{(K_M + M(t))(K_O + O(t))}(p_1 aY_N + p_2)$$
$$- p_3\left(Y_N\mu_N \frac{M(t)O(t)}{(K_M + M(t))(K_O + O(t))} - k_N - \frac{Q}{\theta}\right)$$

The solution of control can be obtain from

$$\frac{\partial H}{\partial K_L} = 0$$
$$\frac{O^{sat}}{2000T}\theta K_L + p1\left(O^{sat} - O(t)\right) = 0$$
$$K_L(t) = \frac{-2000Tp1\left(O^{sat} - O(t)\right)}{O^{sat}\theta}$$

Numerical simulation

Numerical simulations are carried out using matlab. The following is the value of the parameters in the equation

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Table 1. Parameter value on model

Parameter	Name	Value	Units	Source
α	Ooxygen consumption by bacteria for metabolism	1.2	mg/mg	(Sunarsih, Purwanto, & Budi, 2013)
K	Kinetic Constant at T	0.0005	day^{-1}	(Sunarsih, Purwanto, & Budi, 2013)
Y_b	The rate of bacterial product	0.09		(Sunarsih, Purwanto, & Budi, 2013)
K_M	Half saturation of substrate bacteria	50	mg/l	(Tchobanoglous, Metcalf, & Eddy, 1979)
K_{DO}	Half saturation DO bacteria	0.1	mg/l	(Sunarsih, Purwanto, & Budi, 2013)
μ_B	Specific growth rate bacteria	0.01	day^{-1}	(Tchobanoglous, Metcalf, & Eddy, 1979)
K_L	Dissolved oxygen inter transfer coefficient	0.8566	mday^{-1}	(Sunarsih, Purwanto, & Budi, 2013)
O^{sat}	DO saturation	5	mg/l	(Sunarsih, Purwanto, & Budi, 2013)
Q	Flow rate entering the pond	10697.53	m^3/time	(S & Sunarsih, 2018)
θ	Pond Volume	4000	m^3	(S & Sunarsih, 2018)
DO_i	Disolved Oxygen in Inlet	0.9	mg/l	(Sunarsih, Purwanto, & Budi, 2013)
OM_i	OM in inlet	250	mg/l	(Sunarsih, Purwanto, & Budi, 2013)
B_i	Bacteria in inlet	490	mg/l	(Sunarsih, Purwanto, & Budi, 2013)
k	bacterial death coefficient	0.06	day^{-1}	(Sunarsih, Rahmania, & Puspita, 2017)

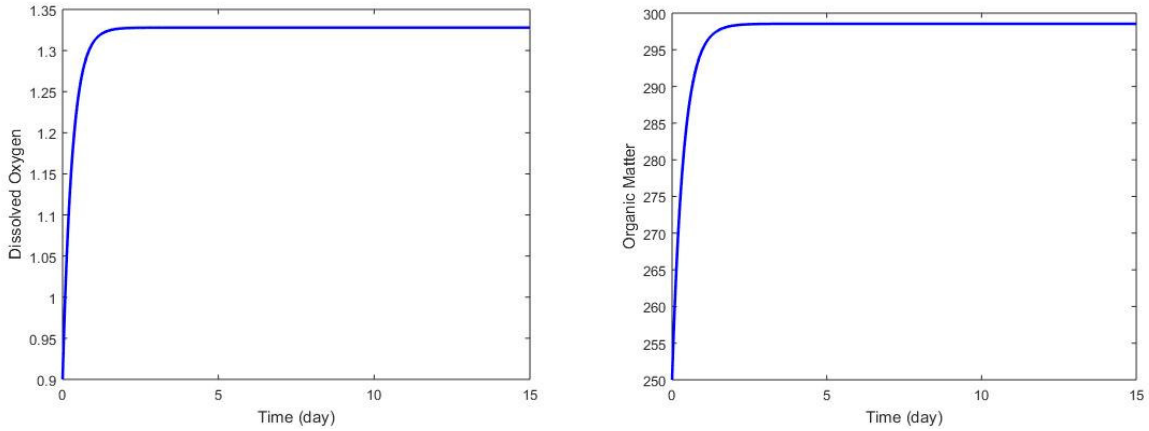


Figure 1. Dissolved oxygen and organic matter with control
$O(0) = 0.9$ mg/l, $M(0) = 250$mg/l, $N(0) = 490$mg/l

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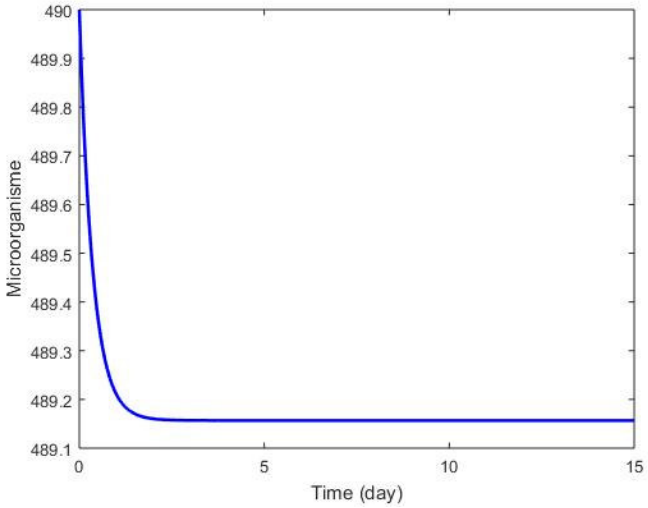


Figure 3. Microorganisme with control $O(0) = 0.9$ mg/l, $M(0) = 250$mg/l, $N(0) = 490$mg/l

Conclusion

The problem of optimal control in wastewater treatment is very difficult to do because of the complexity of the variables involved. In this study we discuss optimal control to minimize aerator energy by controlling the aerator coefficient. From what we examined, it was found that the Dissolved Oxygen value must always be at a low number. And because of the low O value, the amount of BOD has also increased.

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Analysis of survival for cox proportional hazard regression time to correct COVID-19 patients

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Abstract. *Indonesia has been exposed to COVID-19 pandemic since March 2020. The number of COVID-19 patients was equally high all across Indonesia including North Sumatra. One of the hospitals dealt with high rates of COVID-19 cases in North Sumatra is RSUD Dr. Pirngadi Medan. This study used RSUD Dr. Pirngadi as a research site to collect data on COVID-19 cases. The variables used in this study, i.e.: the length of hospitalization for patients who recover from COVID-19 (dependent variable); age (independent variable); and giving vitamins and levofloxacin antibiotics based on the COVID-19 Management Guidelines book. This study uses cox proportional hazard regression with efron parameter estimation. The results of the analysis using the backward and AIC (Akaike Information Criterion) methods showed that the variable that affects the length of time for recovering patients with COVID-19 was the administration of vitamins. By using the efron method, patients who were given vitamins had a hazard ratio of 0.6735 faster to recover than patients who were not given vitamins. The model obtained was* $h(t,X) = h_0(t)\,exp(-0.4126X_2)$. *However, by using the exact method, it was found that patients who were given vitamins had a hazard ratio of 0.6519 faster to recover than patients who were not given vitamins and the model obtained was* $h(t,X) = h_0(t)\,exp(-0.4279X_2)$.

Keywords: COVID-19, cox proportional hazard regression, survival analysis.

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Introduction

In 2019 a virus emerged called COVID-19. The virus first appeared in Wuhan, China and spread all over the world. This virus is caused by SARS or the so-called Severe Acute Respiratory Syndrome [1]. Indonesia is one of the countries whose population has been affected by COVID-19. COVID-19 arrived in Indonesia in March 2020. There are several characteristics of people who are very vulnerable to the COVID-19 virus, such as: elderly people, children, medical personnel, and people with a history of certain diseases [2]. One of the hospitals in Indonesia that accepts inpatients for COVID-19 is RSUD Dr. Pirngadi Medan. So in this study the researchers used RSUD Dr. Pirngadi as a research site to collect data on COVID-19 inpatients.

Survival analysis is a statistical method that aims to show an analysis of data that has a relationship with time. Where the time in question is the time at the beginning of an event, such as exposure to a disease and the end of an event, for example, healing from the disease [3].

Cox proportional hazard regression in this study aims to determine whether or not the independent variable affects the dependent variable. Where, the dependent variable in this study is the length of time for recovery of inpatients of COVID-19 RSUD Dr. Pirngadi Medan. The author uses cox proportional hazard regression because in this study it is not known the distribution of the survival time used. So, by using Cox proportional hazard regression, even though the distribution of survival time used is unknown, the parameter estimates can still be trusted [4]. The dependent variable in the CPH regression is a survival time of an object against a certain event. Such as data when a patient experiences a disease with calculations starting from the beginning of the incident until the occurrence of a certain event, namely: death, recovery, and other events [5].

Survival analysis for ties is used if the study has many co-occurrences. Ties are a common occurrence experienced by one or more individuals. The method that can be used to overcome a ties is the partial likelihood efron and exact methods.

Literature review

Coronavirus

In 2019 a virus emerged called COVID-19. The virus first appeared in Wuhan, China and spread all over the world. This virus is caused by SARS or the so-called Severe Acute Respiratory Syndrome [1]. Indonesia is one of the countries whose population has been affected by COVID-19. COVID-19 arrived in Indonesia in March 2020. There are several characteristics of people who are very vulnerable to the COVID-19 virus, such as: elderly people, children, medical personnel, and people with a history of certain diseases [2]. One of the hospitals in Indonesia that accepts inpatients for COVID-19 is RSUD Dr. Pirngadi Medan. So in this study the researchers used RSUD Dr. Pirngadi as a research site to collect data on COVID-19 inpatients.

Survival analysis

Survival analysis is one of the statistical methods for data relating to a time when the event or events occurred until the end of the event. The initial event was the patient at the time of

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being exposed to or exposed to COVID-19 and the end of the incident referred to in this study was recovery from COVID-19 disease [3]. One of the purposes of survival analysis is to estimate and interpret the survival and hazard functions [6].

Sensor data

According to Lee [4] censored data is data on an individual or patient who does not have complete data. This is because the individual cannot be observed until the study has ended, the individual disappeared during the process of the study, or it could be because the individual died. There are 3 types of censorship [7], namely: right sensor, left sensor, and interval sensor.

Survival function and hazard function

Functions of Ket n Probability

Assumed that if T is a non-negative random variable for the interval $[0,\infty]$intended to indicate the time to live in a population, where $f(t)$is the probability density function of t such that the function of the cumulative distribution is $F(t)$[6]:

$$F(t) = P(T \leq t) = \int_0^t f(x)dx \qquad (1)$$

Based on the above equation, the derivatives are obtained, namely:

$$f(t) = \frac{d(F(t))}{dt} = F'(t) \qquad (2)$$

Survival function

The notation for this function is $S(t)$. The survival function is the probability that an individual can survive or not face an event longer than time t with the following equation Lee [4]:

$$S(t) = 1 - P(T \leq t) = 1 - F(t) \qquad (3)$$

The survival function can be expressed in the form of an equation function of the probability density:

$$F(t) = P(T \geq t) = \int_t^{\infty} f(t)dt \qquad (4)$$

In such a way that the relationship between the probability density function, the cumulative distribution function and also the survival function is obtained, namely:

$$f(t) = 1 - S(t) = \frac{d(F(t))}{dt} = \frac{d(1 - S(t))}{dt} = F'(t) = S'(t)$$
$$f(t) = F'(t) = -S'(t) \qquad (5)$$

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Hazard function

The hazard function's definition is the risk level for an event to occur. The notation of the hazard function is $h(t)$. It is assumed that it T is a non-negative random variable for the interval $[0,\infty]$representing the time the individual encounters an event for the population. So the probability of an individual encountering an event for the interval is $(t+\Delta t)$ shown in the function hazard [6].

$$h(t)=\lim_{\Delta t\to 0}\frac{P(t\le T<t+\Delta t|T\ge t)}{\Delta t}$$

$$h(t)=\lim_{\Delta t\to 0}\frac{P(t\le T<t+\Delta t,T\ge t)}{P(T\ge T).\Delta t}$$

$$h(t)=\lim_{\Delta t\to 0}\frac{P(t\le T<t+\Delta t)}{S(t).\Delta t}$$

$$h(t)=\frac{1}{S(t)}.\lim_{\Delta t\to 0}\frac{P(t\le T<t+\Delta t)}{\Delta t}$$

$$h(t)=\frac{1}{S(t)}.\lim_{\Delta t\to 0}\frac{P(T<t+\Delta t)-P(T<t)}{\Delta t}$$

$$h(t)=\frac{1}{S(t)}.\lim_{\Delta t\to 0}\frac{F(t+\Delta t)F(t)}{\Delta t}$$

$$h(t)=\frac{f(t)}{S(t)} \qquad (6)$$

$$h(t)=\frac{f(t)}{S(t)}=\frac{-S'(t)}{S(t)}$$

$$h(t)=-S'(t)\frac{1}{S(t)}$$

$$h(t)=-S'(t)\log S(t)$$

$$h(t)=-S'(t)\frac{d\log S(t)}{dS(t)}$$

$$h(t)=-\frac{dS(t)}{dt}.\frac{d\log S(t)}{dS(t)}$$

$$h(t)=-\frac{d}{dt}\log S(t)$$

CPH regression/cox proportional hazard

The CPH regression aims to determine the effect between the dependent and independent variables. CPH regression is also included in the semiparametric regression. The reason is that this regression has both parametric and non-parametric components, does not have

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assumptions about the nature or shape of the distribution. Thus, this regression is good if the distribution of survival times is not seen with certainty. Thus, the results of the parameter estimates are reliable [4]. The following is the equation for the CPH regression:

$$h(t,x) = h_0(t)\exp(\beta_1 x_1 + \beta_2 x_2 + ... + \beta_p x_p) = h_0(t)\exp\left(\sum_i^p \beta_i x_i\right) \quad (7)$$

Where:

$h(t,X)$ = *Hazard* function

$h_0(t)$ = Basic function of *hazard*

β_1 = i -th regression coefficient

X_i = The value of the independent variable i

Based on the above equation, the basic hazard function is unknown. However, the equation provides useful information, namely the hazard ratio. So, if the value $h_0(t)$ is known, then the value of the hazard function includes the shape of the data distribution for the time so that the equation of the hazard forms a parametric equation. However, in the CPH regression the value of the hazard rate in one individual and divided by the value of the hazard ratio in another individual is shown as follows: It is assumed that the first individual has a hazard value rate $h_A(t,X^*$ with $\mathrm{X}^* = (X_1^*, X_2^*, ..., X_p^*).(X_1, X_2, ..., X_p)$. So the hazard *ratio* is:

$$HR = \frac{h_A\left(t,X^*\right)}{h_B\left(t,X^*\right)} = \frac{h_0(t)\exp\left(\sum_i^p \beta_i X_i^*\right)}{h_0(t)\exp\left(\sum_i^p \beta_i X_i^*\right)}$$

$$HR = \exp\left(\sum_i^p \beta_i X_i^* - \sum_i^p \beta_i X_i\right) \quad (8)$$

$$HR = \exp\left(\sum_i^p \beta_i \left(X_i^* - X_i\right)\right)$$

Parameter estimation with Efron method

In survival analysis, it is often found that there is a ties or what is called a joint event. The point is that sometimes two or more individuals can experience events at the same time. So, if *ties arise, it* creates a problem to create partial likelihoods, such as determining the risk set members. According to Klein [7] as for alternative methods that can be used, one of them is partial likelihood efron. Here are the general equations:

$$L(\beta) = \prod_{t=1}^{r} \frac{\exp\left(\sum_{I\in D(t_i)} \sum_{j=1}^{p} \beta_j x_{ij}\right)}{\prod_{k=1}^{d_i}\left[\sum_{I\in R(t_1)} \exp\left(\sum_{j=1}^{p} \beta_j x_{ij}\right) - \frac{k-1}{d_i} \sum_{I\in D(t_i)} \exp\left(\sum_{j=1}^{p} \beta_j x_{ij}\right)\right]} \quad (9)$$

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Where:

$D(t_i)$ = the set of individuals who undergo an event when t_i

$R(t_i)$ = the set of individuals has a risk of undergoing a moment event t_i

k = individuals who live together

d_i = number of ties observed when t_i

Parameter estimation with exact method

The following is a partial likelihood function using the exact method [8]:

$$L(\beta) = \prod_{i=1}^{r} \frac{\exp\left(\sum_{l \in D(t_i)} \sum_{j=1}^{p} x_{lj}(t_i)\beta_j \right)}{\sum_{l \in R(t_i)} \exp \sum_{j=1}^{p} x_{lj}(t_i)\beta_j} \quad (10)$$

Where:

$D(t_i)$ = the set of individuals who undergo an event when t_i

$R(t_i)$ = the set of individuals has a risk of undergoing a moment event t_i

$l = \{l_1, l_2, \ldots, l_{d_i}\}$ element of $R(t_i)$

d_i = number of ties observed when t_i

Parameter test

There are two tests in testing the significance of the parameters, namely: simultaneous test and partial test

Simultaneous test

The model test was conducted to see the role of the independent variable on the dependent variable simultaneously or as a whole. The simultaneous test is also known as the chi square model test:

$H_0 : \beta_1 = \beta_2 = \ldots = \beta_i = 0$

H_1 : there is at least one parameter $\beta_i \neq 0$, with $i = 1, 2, \ldots, p$ G test statistic or *Likelihood Ratio Test*

$$G = -2[lnL_R - lnL_f] \quad (11)$$

where:

L_R : *partial likelihood* of the initial model

L_f : *partial likelihood* of final model

Partial test

Partial testing is used to test the effect of each β_i in the obtained model. The partial test results will show whether the independent variable is eligible to be included in the model or not (?). The hypotheses used for each variable are as follows:

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$H_0 : i = 0$

$H_1 : \beta_i \neq 0$ Wald's test statistics (W):

$$|Z| = \left| \frac{\hat{\beta}_2}{SE(\hat{\beta}_2)} \right| \quad (12)$$

Where:

$SE(\hat{\beta}_i)$: Standard *error of parameter* estimator $_i$

$\hat{\beta}_i$: Parameter estimation *of* $_i$

$MS_{\text{Re}s}$: The sum of the residual squares

S_{xx} : Sample variables on independent variables X

$SS_{\text{Re}s}$: The sum of the squares of the difference between the real value and the value of *real* average Y

The best model

The purpose of doing the best model is to see the relationship between survival time and independent variables correctly by using the elimination of backward and the AIC value. The process of doing backward elimination is eliminating or removing variables gradually [9]:

$$AIC = -2In\hat{L} + 2k \quad (13)$$

Where,

$\hat{L}$ = the value of the *likelihood*

k : the number of parameters

Note that the best model is selected on the variable that has the smallest AIC.

Assumption test on proportional hazard

In carrying out the test of the Cox proportional hazard assumption, the thing that will be done is the Spearman rank correlation test. Then it will be seen is the value of its *p-value* using a significance level of 0.05. Where, to check the PH assumption by using goodness of fit will be seen from the correlation. To see the correlation coefficient between survival time and Schoenfeld residual, it will be calculated using Spearman's rank correlation coefficient. According to Kleinbaum [3] states that a measure used in checking the PH assumption is the *p-value*. If the *p-value* < 0:05 then the tested covariate does not meet the PH assumption. Where, the Spearman rank correlation coefficient formula is:

$$p = 1 - \frac{6\sum d_i^2}{n(n^2 - 1)} \quad (14)$$

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the test statistic is *schoenfeld residuals* . The value of the schoenfeld residuals on the *j - th covariate in the -i* individual is:

$$r_{ji} = \delta_i \left\{ x_{ji} - \hat{\alpha}_{ji} \right\} \quad (15)$$

Where,

δ_i = individual status

x_{ji} : value on the explanatory variable

$\hat{\alpha}_{ji}$ = weighted average

Results and discussion

Data collection

The data used in this study is data on inpatients of COVID-19 RSUD Dr. Pirngadi Medan on March 26, 2020 to September 26, 2020. With the following data characteristics:

Parameter estimation with efron method

This study uses CPH regression where the parameter estimation used is efron and to obtain the variables with the best model, backward elimination is used to determine the eliminated or not eliminated variables to obtain the most influential variables based on the best model results. By using the R Studio $h(t,X) = h_0(t)\exp(0.05147X_1 - 0.38858X_2 - 0.23236X_3)$ software, the initial model is obtained. The best model that is formed in the Cox proportional hazard regression using the efron method with backward elimination is as follows: $h(t,X) = h_0(t)\exp(-0.4126X_2)$.

Table 1. AIC value

No.	Formed models	AIC value
1.	All independent variables	982.8363
2.	All independent variables except the age variable	980.9145
3.	All independent variables except for the variable age and administration of levoflaxin antibiotik	980.3337

Cox proportional hazard regression parameter significance test

Overall test

This test is used to determine whether there is an influence between the independent variables on the dependent variable. If the *p-value* is less than 0.05. So, H_0 it is rejected, which means the model is feasible to use. Overall test with test statistic with chi-square distribution using likelihood ratio. The following is a hypothesis for the overall test:

Hypothesis:

$H_0 : \beta_2 = 0$ (The independent variable has no effect on the dependent variable)

$H_1 : \beta_2 \neq 0$: (There are one or more independent variables that have an influence on the dependent variable)

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Significance Level: $\alpha = 5\% = 0.05$

Critical Region: Reject H_0 if *p-value* ≤ 0.05 or $G \geq \chi^2_{0.05;2}$

Test statistics:

p-value : 0.0313

$G = -2\left[\ln L_R - \ln L_f\right]$

$= 12.390$

Decision:

H_0 rejected on the grounds that the *p-value* $< \alpha$ or $G > \chi^2_{0.05;2}$.

Conclusion:

The conclusion is that it is H_0 rejected because *the p-value* $< \alpha$ i.e. that 0.0313 < 0.05. Based on the test results on the value $G > \chi^2_{0.05;2}$ obtained that 12,390> 5.99. So, based on the conclusion that there are independent variables that have an influence on the dependent variable. Thus, the *overall test is* rejected and a partial test will be carried out to see whether each regression coefficient has an effect or not.

Partial test

The partial test is used to determine whether the independent variable has a significant effect on the dependent variable. Partial test is used on variables that have been formed into the best model. The following are the results of a partial test on the vitamin administration variable that has been formed into the best model:

Hypothesis:

$H_0 : \beta_2 = 0$ (the variable of giving vitamins has no effect on the length of time for recovery of COVID-19 inpatients at Dr. Pirngadi Hospital, Medan City)

$H_1 : \beta_2 \neq 0$ (the variable of vitamin administration affects the length of time for recovery of inpatients with COVID-19 at Dr. Pirngadi Hospital, Medan City)

Significance level: $\alpha = 5\% = 0.05$

Critical area: H_0 rejected if *the p-value is* $\leq$ significant level or $W \geq Z_{0.05/2}$

Test statistics:

p-value = 0.0313

$$|W| = \left|\frac{\hat{\beta}_2}{SE\left(\hat{\beta}_2\right)}\right| = \left|\frac{-0.4126}{0.1916}\right| = 2.1534$$

Decision: H_0 it was rejected because *of the p-value* $\leq$ level of significance or $|W| \geq Z_{0.05/2}$,

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Conclusion:

H_0 rejected with a significance level of 0.05. Where, *p-value* < significance level is 0.0313 < 0.05. Based on the calculation results $|W| > Z_{\alpha/2}$ obtained that 2.1534> 1.96. The conclusion is that independent variables support H_1 and cause the variable of giving vitamin an effect on the length of time recovering from COVID-19 inpatients at Dr. Hospital. Pirngadi Medan City.

***Cox proportional hazard* regression assumption test**

In the Cox proportional hazard regression assumption test, the value used in the Cox proportional hazard regression assumption test is obtained based on the results of the Schoenfeld residual value using R software. The steps in testing the Cox proportional hazard regression assumption using R software are as follows:

Table 2. Cox proportional hazard regression assumption test

Variable	Information	*p-value*	ρ	Decision
X_2	Giving vitamins	0.25	-0.1	H_0 failed to reject

Cox proportional hazard regression assumption table above using R *software* with a significance level of 0.05, it was found that it H_0 failed to be rejected for the variable X_2. This is caused by the probability *p-value* > (0.05). So that it is obtained that there is data that shows that it H_0 failed to be rejected. So that the variables X_2 are met in the CPH assumption test.

Hazard ratio value

By using the R Studio software, it is obtained that the hazard ratio value is 0.6619. In this way, COVID-19 hospitalized patients who were given vitamin 0.6619 recovered faster than patients who were not given vitamins.

Parameter estimation with exact method

This study uses CPH regression where the parameter estimation used is *exact* and to obtain the variables with the best model, backward elimination is used to determine the eliminated or not eliminated variables to obtain the most influential variables based on the best model results. By using the R Studio $h(t,X) = h_0(t)\exp(0.05643X_1 - 0.39821X_2 - 0.24322X_3)$ software, the initial model is obtained. The best model that is formed in the *Cox proportional hazard regression* using the *efron method with backward* elimination is as follows: $h(t,X) = h_0(t)\exp(-0.4279X_2)$.

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Table 3. AIC value

Model	Formed models	AIC value
1.	$e^{(\beta_1 X_1+\beta_2 X_2+\beta_3 X_3)}$	665.1127
2.	$e^{(\beta_2 X_2)}$	662.5099

Based on the table above, a table of AIC values was obtained using the R Studio software. For each AIC value, the best model can be seen from the smallest AIC value. Where, the smallest AIC value is 662.5099. In accordance with the previous best parameter estimation results, it was found that the vitamin administration variable was the model with the best estimation results as well as the AIC value using the R Studio software, the smallest AIC value was the best model.

Cox proportional hazard regression parameter significance test

Overall test

This test is used to determine whether there is an influence between the independent variables on the dependent variable. If the *p-value* is less than 0.05. So, H_0 it is rejected, which means the model is feasible to use. *Overall* test with test statistic with chi-square distribution using likelihood ratio. The following is a hypothesis for the overall test:

Hypothesis:

$H_0 : \beta_2 = 0$ (The independent variable has no effect on the dependent variable)

$H_1 : \beta_2 \neq 0$: (There are one or more independent variables that have an influence on the dependent variable)

Significance Level: $\alpha = 5\% = 0.05$

Critical Region: Reject H_0 if *p-value* ≤ 0.05 or $G \geq \chi^2_{0.05;2}$

Test Statistics:

p-value : 0.0313

$G = -2\left[\ln L_R - \ln L_f\right]$

$= 23.213$

Decision:

H_0 rejected on the grounds that the *p-value* $< \alpha$ or $G > \chi^2_{0.05;2}$.

Conclusion:

The conclusion is that it is H_0 rejected because *the p-value* $< \alpha$ i.e. that 0.0313 < 0.05. Based on the test results on the value $G > \chi^2_{0.05;2}$ obtained that 23.21 > 5.99. So, based on the conclusion that there are independent variables that have an influence on the dependent variable. Thus, the *overall test is* rejected and a partial test will be carried out to see whether each regression coefficient has an effect or not.

Partial test

Partial test is used to find out that the independent variable has a significant effect on the dependent variable. Partial test is used on variables that have been formed into the best

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model. The following are the results of a partial test on the vitamin administration variable that has been formed into the best model:

Hypothesis:

$H_0 : \beta_2 = 0$ (the variable of giving vitamins has no effect on the length of time for recovery of COVID-19 inpatients at Dr. Pirngadi Hospital, Medan City)

$H_1 : \beta_2 \neq 0$ (the variable of vitamin administration affects the length of time for recovery of inpatients with COVID-19 at Dr. Pirngadi Hospital, Medan City)

Significance level: $\alpha = 5\% = 0.05$

Critical area: H_0 rejected if *the p-value is* ≤significant level or $W \geq Z_{0.05/2}$

Test statistics:

p-value = 0.0386

$$|W| = \left| \frac{\hat{\beta}_2}{SE\left(\hat{\beta}_2\right)} \right| = \left| \frac{-0.4279}{(0.2068)(-0.4279)} \right| = \left| \frac{-0.4279}{-0.08848972} \right| = 4.8356$$

Decision:

H_0 it was rejected because *of the p-value* ≤level of significance or $|W| \geq Z_{0.05/2}$,

Conclusion:

H_0 rejected with a significance level of 0.05. Where, *p-value* < significance level is 0.0386 < 0.05. Based on the calculation results $|W| > Z_{\alpha/2}$ obtained that 4.8356> 1.96. The conclusion is that there are independent variables that support H_1 and cause the variable of giving vitamin an effect on the length of time recovering from COVID-19 inpatients at Dr. Hospital. Pirngadi Medan City.

Cox proportional hazard regression assumption test

In the Cox proportional hazard regression assumption test, the value used in the Cox proportional hazard regression assumption test is obtained based on the results of the Schoenfeld residual value using R software. The steps in testing the Cox proportional hazard regression assumption using R software are as follows:

Table 4. Cox proportional hazard regression assumption test

Variable	Information	*p-value*	ρ	Decision
X_2	Giving vitamins	0.30	-0.087	H_0 failed to reject

Cox proportional hazard regression assumption table above using R software with a significance level of 0.05, it was found that it H_0 failed to be rejected for the variable X_2. This is caused by the probability *p-value* > (0.05). So that it is obtained that there is data

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that shows that it H_0 failed to be rejected. So that the variables X_2 are met in the CPH assumption test.

Hazard ratio value

By using the R Studio software, it is obtained that the hazard ratio value is 0.6519. In this way, COVID-19 hospitalized patients who were given vitamins 0.6519 times faster recovered than patients who were not given vitamins.

Conclusions and recommendations

Conclusion

By using the efron and exact methods, it was found that the variable that affects the length of time for recovery of COVID-19 patients is the variable of vitamin administration. The equation of the best regression model in CPH regression with the efron method, namely:

$$h(t,X) = h_0(t)\exp(-0.4279X_2)$$

The equation of the best regression model in the CPH regression with the exact method, namely:

$$h(t,X) = h_0(t)\exp(-0.4279X_2)$$

The *hazard ratio* value obtained from the administration of vitamins with the *efron method is* 0.6 735. In such a way that patients hospitalized for COVID-19 who were given vitamin 0.6 735 times faster recovered than patients who were not given vitamins. The *hazard ratio* value obtained by giving vitamins with the *exact method* is 0.6519. In this way, COVID-19 hospitalized patients who were given vitamin 0.6519 recovered faster than patients who were not given vitamins.

Recommendations

For further research with similar methods and cases, this study can be used as a guideline or as a reference and should add other variables, such as disease history, respiratory rate, and other drugs consumed. So that further research can be more complex and have tremendous benefits in dealing with cases of long recovery time for COVID-19 patients.

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Frieze group application in the development of north sumatra batik motifs

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Abstract. *Batik is a form of cultural art in the form of patterns of dots and lines on the surface of the cloth with unique and the same motifs and patterns. Indonesia is a large nation with a diverse culture so it has rich motifs, including batik from North Sumatra. The North Sumatran batik motifs describe some ethnic cultures in this region such as Simalungun, Toba Batak, Karo, Mandailing, Malay, Nias, and Dairi. This study developed 10 basic motifs from six North Sumatran batik fabrics with frieze patterns such as 1 Niosiapi-api, Nio Iozasai, dan Niosolafiga motif; 2 Desa Nauwaluh dan Anting Karo motifs; 2 Perbunga Kembang dan Perkukup motifs; 1 Bindu motif; 3 Payung, Tampuk Pinang, dan Bunga Cengkeh motifs; dan 1 Helputor dan Pinar Apul-apul motif. The development of basic motifs was performed with the help of the Matlab application resulting in 60 new motif variations through 11, 1m, 1g, 12, mm, and mg patterns.*

Keywords: Frieze Group, Batik, Pattern, Symmetry

Introduction

In this modern era, batik is not identical to formal clothing for parties or formal events, but for other non-formal events such as daily clothes, school uniforms, and others. The word batik comes from the Javanese language, "Amba" which means broad and "tik" which means dots. Thus, batik can be defined as one of the fabrics with Indonesian drawings and then it is by other processes with certain techniques [1].

As a cultural heritage, Batik is growing rapidly throughout Indonesia, including in North Sumatra. North Sumatran batik motifs have distinctive characteristics and patterns that are diverse, attractive, and depict local ethnic groups such as Batak Toba, Batak Simalungun, Karo, Mandailing, Pakpak, Dairi and Central Tapanuli, Malay, Deli and Nias. Besides, batik motif also takes on the existing Batak Ulos fabrics.

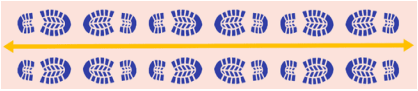
The United Nationals Educational Scientific and Cultural Organization (UNESCO) recognized batik on October 2, 2009. It becomes a big support for Indonesian entrepreneurs in marketing batik

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products to the international market which indeed influences the economic development of the Indonesian [2]. To fulfill the market needs, it is important to create new motifs while still maintaining the basic characteristics of the cloth, for example using the Frieze pattern in mathematics.

Frieze Group is a symmetrical group created from a one-way translation and forms a linear pattern that repeats in one direction [3]. A symmetry group is an isometric set that forms a group using the function composition operation. The Frieze pattern has the characteristic of being formed by translation [4]. The Frieze pattern is a discrete group belonged to the plane symmetry group which is a subgroup of isomorphic translation [5], [6], [7], [8]. The Frieze pattern covers 7 types and is symbolized based on two characters. The first character has no vertical reflection and is symbolized by (1) and if there is a vertical reflection, it is symbolized by (m). In the second character, if there is no other isometry, it is symbolized by (1), while horizontal reflection is symbolized by (m), a glide reflection is symbolized by (g), and a half-turn is symbolized by (2). Frieze patterns have 7 types of repeating patterns that are not isomorphic and related to one-plane symmetry groups such as translation, rotation, reflection, and shear reflection [9]. The seven Frieze patterns are presented in the following table.

Table 1. Frieze patterns [1]

Types	Patterns	Types	Patterns
Pattern *11*		Pattern *m1*	
Pattern *1m*		Pattern *mm*	
Pattern *1g*		Pattern *mg*	
Pattern *12*			

Based on the character of the Frieze pattern, pattern 11 experiences one-way translation only, while character 1 has no vertical reflection and character 2 has no other isometry. The 1m pattern experiences one-way translation, character 1 with no vertical reflection and character 2 with horizontal reflection. Pattern 1g experiences one-way translation, character 1 with no vertical reflection and character 2 with horizontal glide reflection. Pattern 12 experiences one-way translation, character 1 with no vertical reflection and character 2 with a glide half-turn (180° rotation). The m1 pattern experiences translation, character 1 with vertical reflections and character 2 with another isometry. The mm pattern has 180° rotations, translation, character 1 with a vertical reflection and character 2 with a horizontal reflection. The mg pattern has character 1 with vertical reflection, character 2 with glide reflection, 180° translation and rotation patterns. The development of traditional cloth motifs has been carried out by [10], [11]. Traditional cloth motifs are developed using the Matlab application.

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Methodology

This study is a follow-up study by [1] concerning the analysis of North Sumatran batik cloth motifs based on the Frieze group. Of the six basic motifs of North Sumatran batik cloth that have a Frieze pattern (see fig 1), the Matlab application was used to develop or produce new motifs. The development steps were carried out through four steps, namely: 1) Coding according to the provisions of the Frieze pattern; 2) Perform "Run" to bring up the display of various fabric names and basic motifs; 3) Choose the fabric motif and pattern to be developed; and 4) Choose from seven existing frieze patterns to develop a basic pattern.

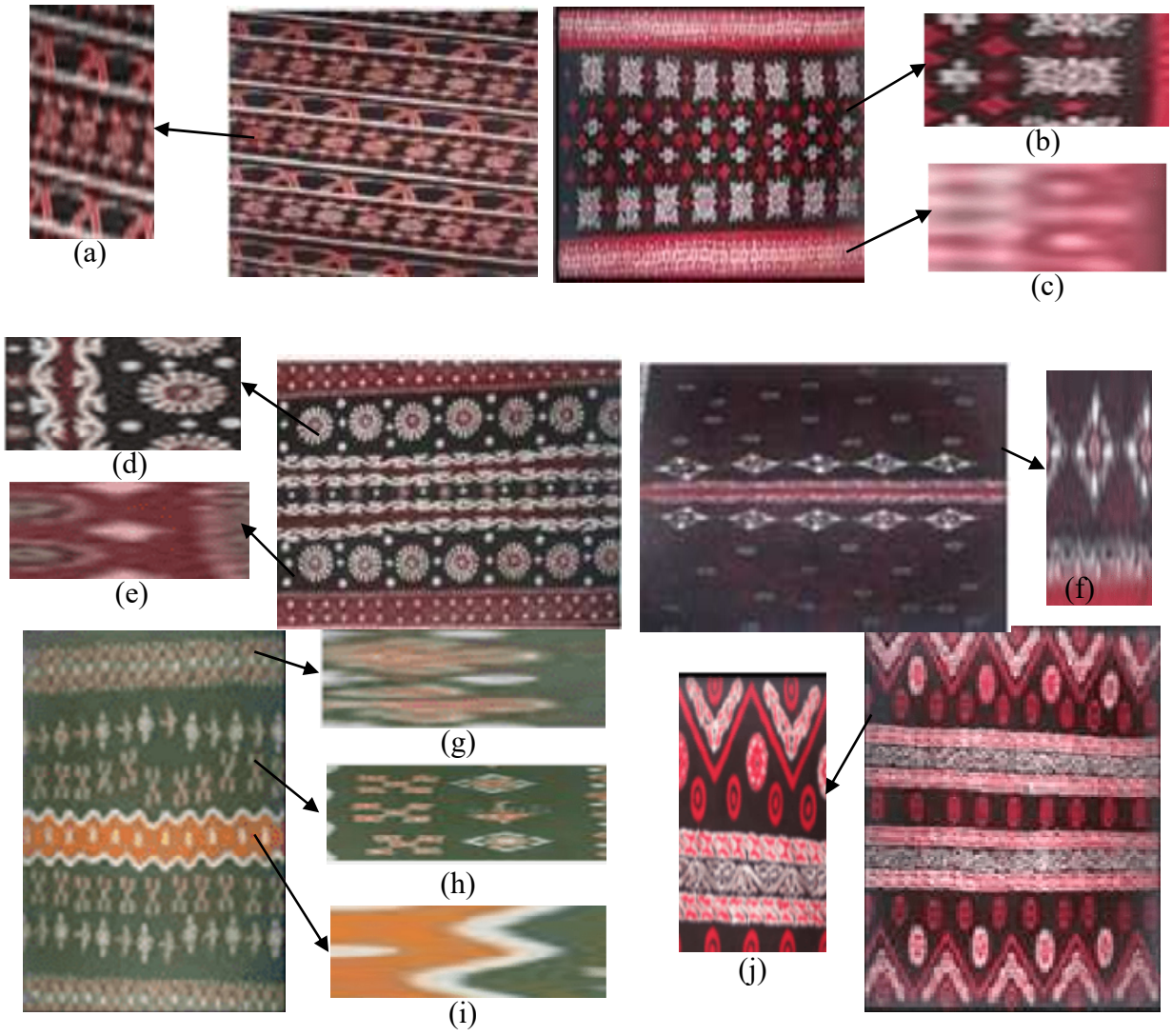


Figure 1. The basic pattern of north sumatran batik motifs. (a) 1 niosiapi-api, nio iozasai, and niosolafiga, (b) nauwaluh and anting karo villages motif, (c) 2 nauwaluh and anting karo villages motifs, (d) 1 perbunga kembang and perkukup motif, (e) 2 perbunga kembang and perkukup motifs, (f) 1 bindu motif, (g) 1 payung, tampuk pinang, and clove flower motif, (h) 2 umbrella, tampuk pinang, and clove flower motifs, (i) 3 payung, tampuk pinang, and clove flower motifs, (j) 1 helputor and pinar apul-apul motif

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These basic motifs cover 1 Niosiapi-api, Nio Iozasai, and Niosolafiga motifs; 2 Nauwaluh and Anting Karo Village motifs; 2 Perbungan Kembang and Perkukup motifs; 1 Bindu motif; 3 Umbrella, Tampuk Pinang, and Clove Flower Motifs; and 1 Helputor and Pinar Apul-apul motif.

Results and discussion

Of the six North Sumatran batiks with Frieze patterns that were developed using the Matlab application, new motifs produced are described below:

Niosiapi-api, nio iozasai, and niosolafiga motifs

Niosiapi-api, Nio Iozasai, and Niosolafiga motifs have a frieze pattern of 11 because character 1 has no vertical reflections and character 2 has no other isometry and translation [1]. The results of the development of this basic batik motif with the help of the Matlab application using the frieze pattern of 11, 1m, 1g, 12, mm, and mg are presented below.

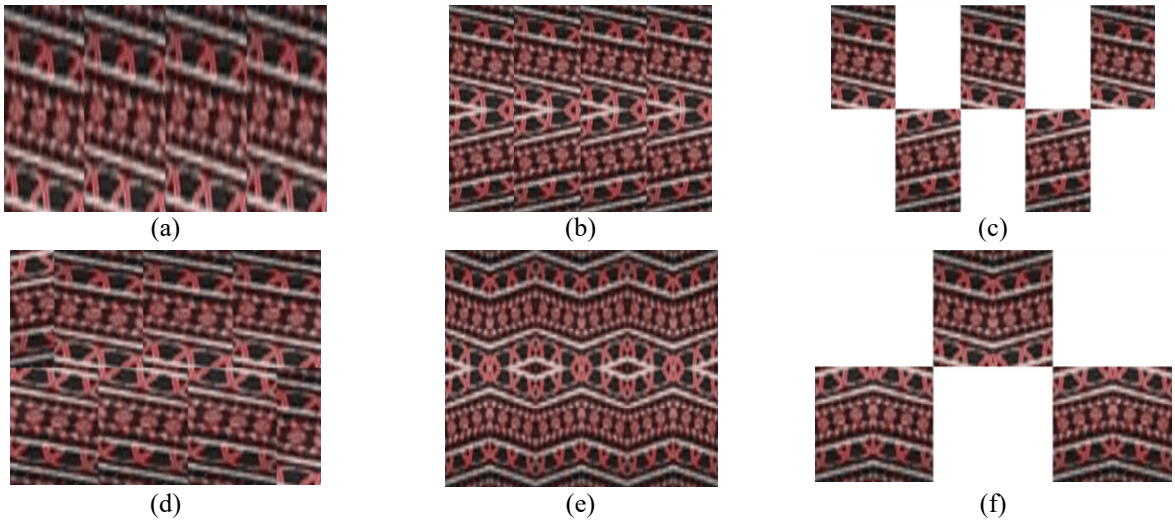


Figure 2. Frieze pattern of niosiapi-api, nio iozasai, and niosolafiga motifs. (a) pattern 11, (b) pattern 1m, (c) pattern 1g, (d) pattern 12, (e) pattern mm, and (f) pattern mg

Nauwaluh and anting karo villages motifs

According to [1], Nauwaluh and Anting Karo Village Motifs 1 and 2 have a frieze pattern of mm. Motif 1 has character 1 (vertical reflection) and character 2 (horizontal reflection) has a 180° rotation and translation. Meanwhile, motif 2 has a rotation of 180°, translation, character 1 with a vertical reflection, and character 2 with a horizontal reflection. The new motifs produced from the basic patterns of motifs 1 and 2 with the help of the Matlab application using frieze patterns 11, 1m, 1g, 12, mm, and mg can be seen below.

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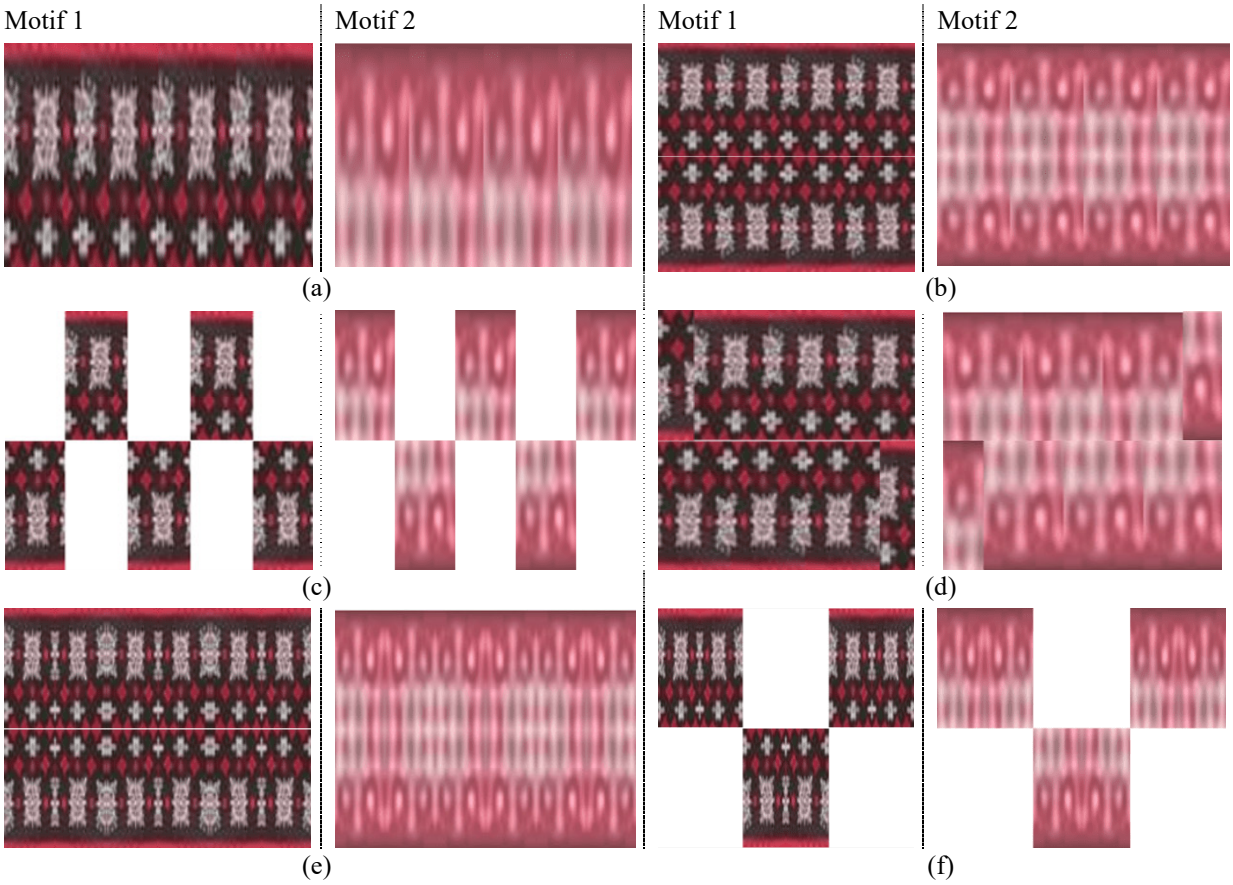
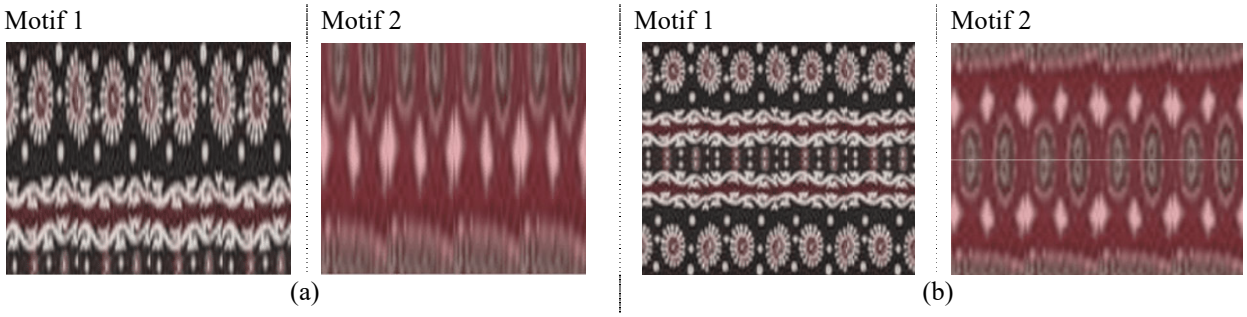


Figure 3. Frieze pattern of nauwaluh and anting karo village motifs 1 and 2. (a) pattern 11, (b) pattern 1m, (c) pattern 1g, (d) pattern 12, (e) pattern mm, and (f) pattern mg

Perbunga kembang and perkukup motifs

Perbunga Kembang and Perkukup motifs 1 and 2 have a frieze pattern in the form of mm. Motif 1 has character 1 (vertical reflection) and character 2 (horizontal reflection, translation and 180° rotation). Meanwhile, motif 2 has a 180° rotation, translation, character 1 with a vertical reflection, and character 2 with a horizontal reflection [1]. The results of the development of these motifs with the help of the Matlab application using the six frieze patterns (11, 1m, 1g, 12, mm and mg) are presented in the following figure.



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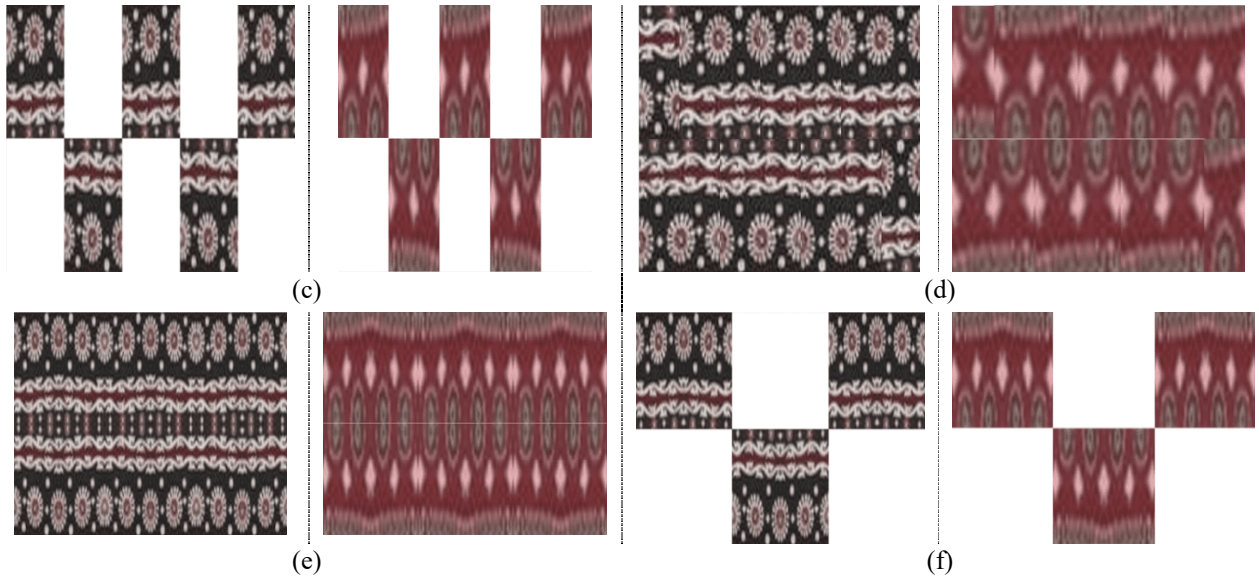


Figure 4. Frieze pattern of perbunga kembang dan perkukup motifs 1 and 2. (a) pattern 11, (b) pattern 1m, (c) pattern 1g, (d) pattern 12, (e) pattern mm, and (f) pattern mg

Bindu motifs

A sheet of Bindu cloth has character 1 (vertical reflection) and character 2 (horizontal reflection, 180° rotation, and translation). In other words, the Bindu motif forms a Frieze pattern in the form of mm [1]. The development of this basic batik motif uses the Frieze pattern of 11, 1m, 1g, 12, mm and mg with the help of Matlab application to produce the following image.

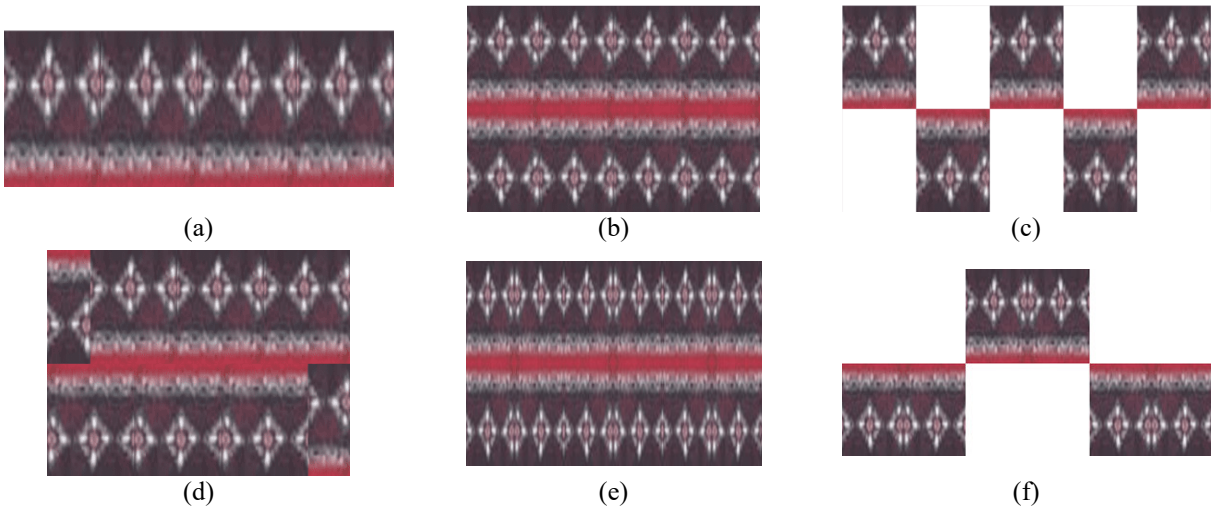
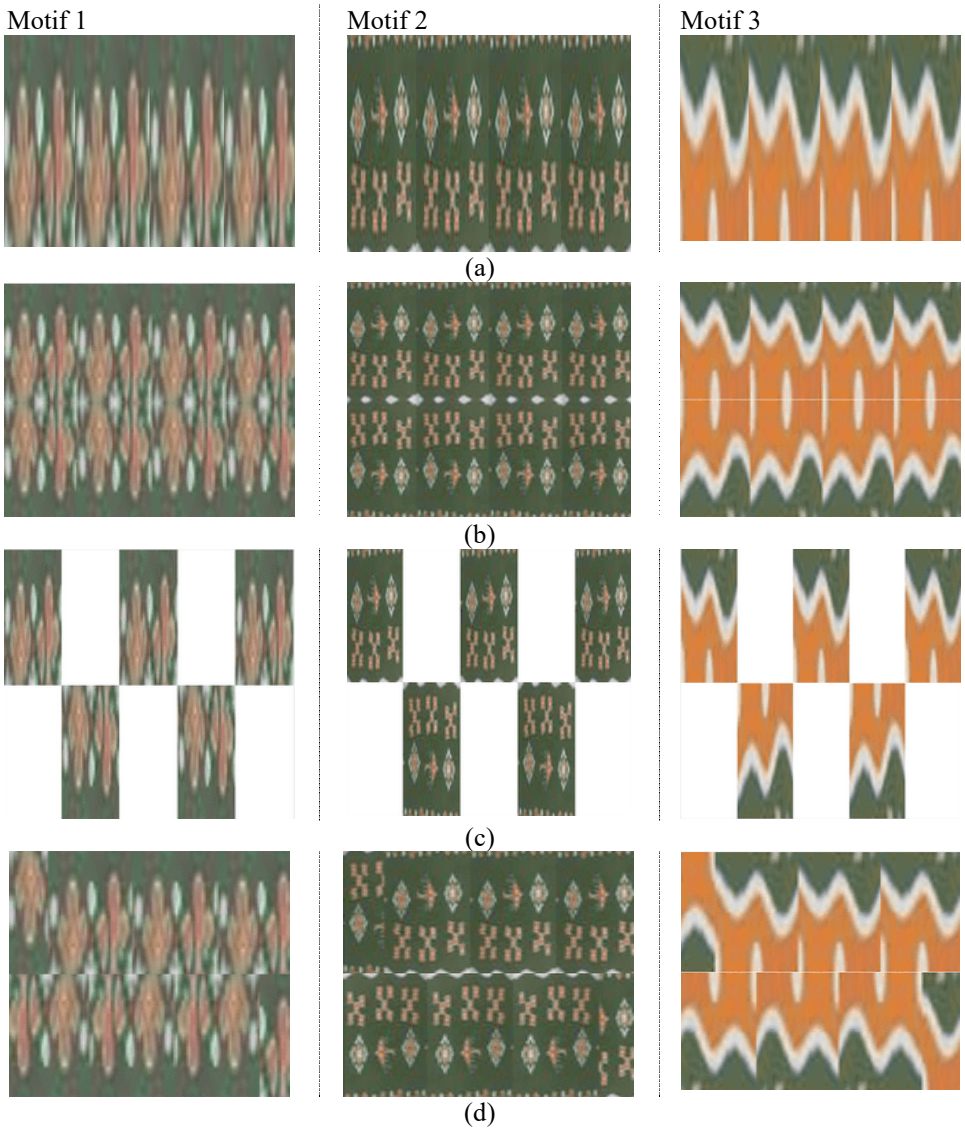


Figure 5. Frieze pattern of bindu motifs. (a) pattern 11, (b) pattern 1m, (c) pattern 1g, (d) pattern 12, (e) pattern mm, and (f) pattern mg

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Payung, tampuk pinang, and bunga cengkeh motifs

Payung Tampuk Pinang, dan Bunga Cengkeh motifs 1 and 3 have a frieze pattern of mm, while motif 2 has a pattern of 11. Motif 1 consists of translation, 180° rotations, character 1 with a vertical reflection, and character 2 with a horizontal reflection. Motif 2 has a translation, character 1 with no vertical reflection, and character 2 with no other isometry. Motif 3 consists of character 1 with a vertical reflection, character 2 with a horizontal reflection, translation, and rotation 180° [1]. The development of these three motifs with the help of Matlab application using the Frieze patterns of 11, 1m, 1g, 12, mm, and mg as presented in the following figure.



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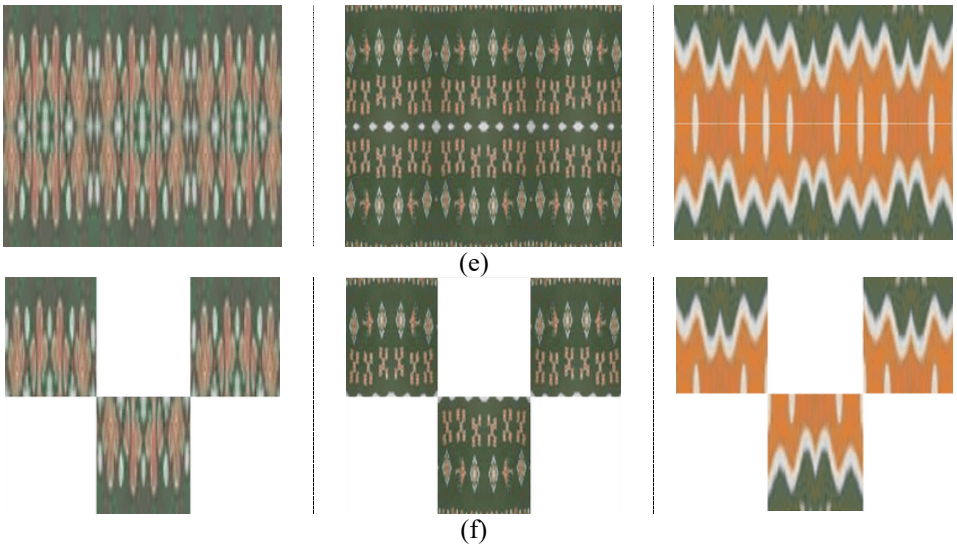


Figure 6. Frieze pattern of umbrella, tampuk pinang, and clove flower motifs 1, 2, and 3. (a) pattern 11, (b) pattern 1m, (c) pattern 1g, (d) pattern 12, (e) pattern mm, and (f) pattern mg

Helputor and pinar apul-apul motifs

The patterns on Helputor and Pinar Apul-apul motifs form a 180° rotation, translation, character 1 with a vertical reflection, and character 2 with a horizontal reflection. This motif forms a Frieze pattern in the form of mm [1]. The following figure shows the results of developing motifs that are more diverse using Frieze patterns of 11, 1m, 1g, 12, mm and mg with the help of the Matlab application.

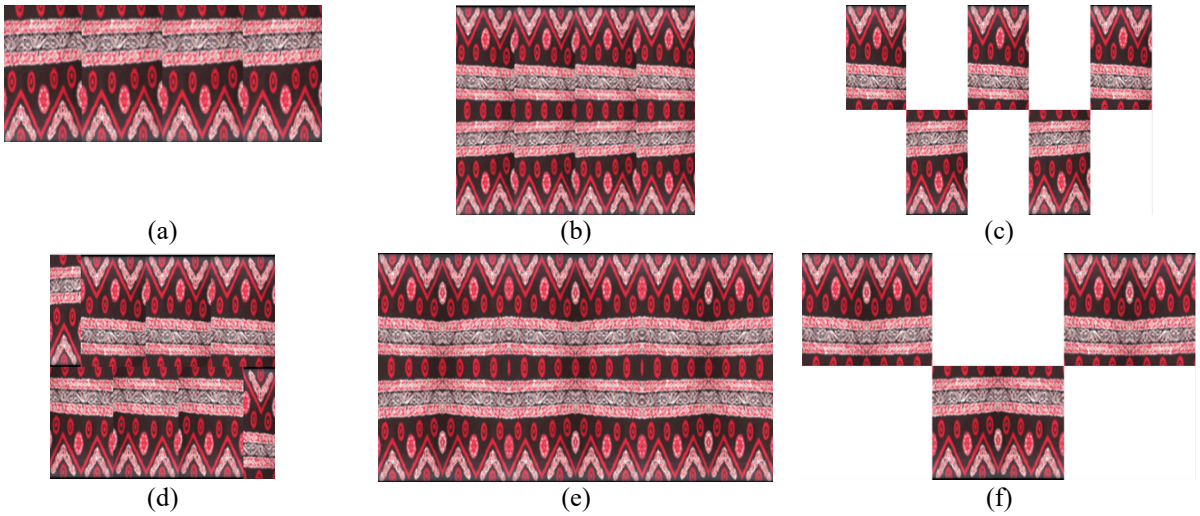


Figure 7. Frieze pattern of helputor and pinar apul-apul motifs. (a) pattern 11, (b) pattern 1m, (c) pattern 1g, (d) pattern 12, (e) pattern mm, and (f) pattern mg

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Conclusion

This study develops the basic motif of North Sumatran batik that has a frieze pattern into more diverse motifs with the help of the Matlab application. The development of 10 basic motifs from 6 batik fabrics consisting of 1 Niosiapi-api, Nio Iozasai, dan Niosolafiga motif; 2 Desa Nauwaluh dan Anting Karo motifs; 2 Perbunga Kembang dan Perkukup motifs; 1 Bindu motif; 3 Payung, Tampuk Pinang, dan Bunga Cengkeh motifs; dan 1 Helputor dan Pinar Apul-apul motif, 60 new motifs obtains using patterns of 11, 1m, 1g, 12, mm, and mg.

Acknowledgements

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Development of animation-based electronic student worksheets with realistic mathematics learning approach

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Abstract. *In general, this research report examines the implementation of learning development using animation-based electronic student worksheets (e-LKPD) through a Realistic Mathematics approach. The purpose of developing this animation-based electronic student worksheets is to make it easier for lecturers to deliver material to students through the presentation of interactive questions, and also to encourage students to study independently using cellphones/laptops at home. The results that have been obtained from this study are as follows: (1) Criteria is valid with an average score of validation of material experts, namely 94.1% and an average score of validation of learning experts is 90.6% in very feasible criteria. In other words, electronic student worksheets products developed using the Realistic Mathematics Education (RME) approach can be utilized in the field for learning activities. (2)The practical category because the results of the student response questionnaire showed that the electronic student worksheets developed was in good criteria with a yes response of 98.3% and a no response of 1.7%. (3) The effective category is based on the aspect of effectiveness with an average score of 80.7 which has achieved learning mastery ≥ 75 and complete learning classically because 80% or more students complete learning individually (out of 34 students 32 of them complete learning and 2 students do not complete).*

Keywords: *electronic student worksheets, animation based worksheets*

Introduction

In today's modern era, technological development is one aspect that can help improve the quality of a country. Technological developments in Indonesia are growing very fast and fast. This development can be seen from the behaviour of people who always use technology in carrying out their daily activities. The learning process can be carried out using technology, so that the learning process becomes practical, effective and efficient. With technology that continues to develop, educators can develop something that can make it easier for them to teach and can invite students to be able to increase their knowledge, in this case the intended students are students. Even so, the

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role of educators, especially lecturers, will never be replaced by technology (machines), but technology is created to facilitate human work, including the teaching and learning process.

Student Worksheets are learning tools that can be used by educators to increase student participation or activity in the teaching and learning process. Along with the development of technology, it has started to change student worksheets into digital form that can be run using computers and even mobile phones or smartphones. Based on the experience of researchers, so far the availability of student worksheets based on electronics is quite necessary for students, especially in the Department of Mathematics Education, Medan State University. To overcome this, student worksheets are needed in electronic form that meet standards, so that they are practical to use and accessible to students. By incorporating animation aspects into student worksheets, it is hoped that it can give more value to student worksheets and increase student interest in learning.

Through the application of Realistic Mathematics Learning in teaching materials, especially student worksheets, it is hoped that it can improve student achievement in certain subjects. For this reason, through this research, the authors plan to develop animation-based electronic student worksheets in Basic Mathematics courses where this course is a basic course for students in the Faculty of Mathematics and Natural Sciences. This is made because it is in line with the characteristics and principles of a realistic mathematics education approach which allows students to develop optimally, because it gives flexibility to students to express their opinions, contextual problems which can facilitate students in solving problems.

Literature review

Andi Prastowo (2015)[4], states Student Worksheets are teaching materials that are printed in the form of sheets that contain material, summaries, and instructions for carrying out learning tasks that students do in relation to Basic Skills achieved. Student worksheets are sheets that contain tasks that must be completed by students in the learning process, and contain steps or procedures for completing tasks. This student worksheet contains what students (should) do, includes doing, observing, and processing. So, we need a form of procedure formulation that is done by students in seeing the phenomenon of work results. Followed by distributing analytical questions to encourage students to associate the observed phenomena with the forms that will be built in the minds of students. According to Endang Widjajanti (2008: 1-2)[7], student worksheets have several functions, namely: a) Directing teaching or introducing an activity in a concrete way b) Accelerating the teaching process c) Knowing material mastered by students d) Optimizing teaching and learning references e) Arousing student interest and motivation f) Facilitating the completion of individual or group assignments g) Improving students' ability to solve problems.

Student worksheets can be implemented electronically by using an application so that the presentation can be more interesting and interactive. In this study, the researcher presented the format contained in the students' worksheets using the Articulate Storyline application. The material is prepared using a Realistic Mathematics Learning (RME) approach. Realistic Mathematics Learning (RME) is a way to help students better understand mathematics by associating realistic situations that students can actually imagine.

In realistic mathematics learning the learning process is transferred to real-world situations. The process of developing mathematical ideas and concepts starting from the real world is called conceptual mathematization. (Sugiyono, 2016) assumes that knowledge is a transformation process that is continuously created and recreated, so that it is not a free entity to be mastered or conveyed. Therefore, the real world of students must be adjusted continuously. Schematically conceptual mathematization is presented in the following figure:

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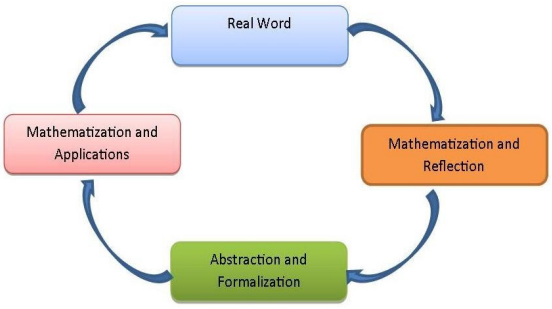


Figure 1. Conceptual mathematical scheme in realistic mathematics learning

Interactive media is media that allows students to interact with the media by practicing their skills and receiving feedback on the material to be explained. The advantage of this media is that it contains a combination of text, graphics, video and audio which will certainly be more interesting and make delivery easier. This means that the participation of students will be larger so that they are able to study material in more depth in accordance with the constructivist paradigm, support the individualization of each student's learning style, which is more adequate so that it is broader in terms of students' conditions, able to simulate an object that cannot be presented in class.

Articulate Storyline is a software that is used as a means of communication, especially presentations and can be used as a support for learning activities. This software has several interesting features compared to other interactive media. Articulate Storyline can be optimally applied to non-face-to-face or e-learning-based learning, because it can be used without an internet network connection. So that it can expedite the learning process without any interference from the internet network. Articulate storylines can be made easily by themselves, both experienced and beginners, can include several forms of files, such as power points, flash and video, then they can be in the form of audio and visuals, sounds and images can be made in the articulate storyline, there is an application for making quizzes without import from files that are outside, provide and provide interactive content because it involves students more in learning.

When creating a project, a scene will be displayed that can be used to display content via slides. This scene can be named according to the contents of the slides in it. For example, the "splash screen" scene which contains the opening display of the created media. So the "splash screen" scene can consist of several slides with content in the form of media titles, creator names and other information. You can add another scene with the name "material" to accommodate several slides with learning material content. In addition to being added as needed in the preparation of learning media. The use and naming of scenes that are structured and neat will later make it easier to link one slide to another.

Methodology

In obtaining good learning tools, a certain procedure is needed, namely by referring to research methods and developing learning tools. The development model used in this research is the Borg and Gall development model (Rochmad, 2012)[12] presented in Figure 1 below.

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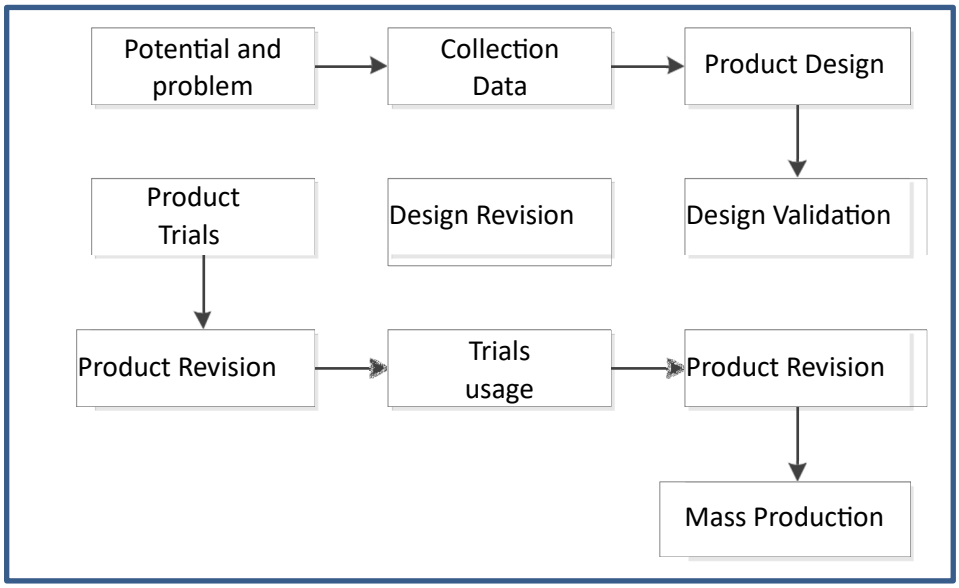


Figure 2. Development stages of hannafin and peck

However, because this study had limited time, the researchers limited the research to 6 steps, so the LKPD product developed was not carried out in 10 steps as previously described. Researchers modify research and development methods consisting of six steps, namely 1) Potentials and problems; 2) Data collection; 3) Product design; 4) Design validation; 5) Design revision; and 6) Product trials.

An explanation of the types of development above is as follows:

1. Potential and Problems
   Potential is something that adds value when it is used. If all the potential that is owned cannot be utilized properly, then this potential will develop into a problem. The problem is the discrepancy between what is expected and what happens or what is planned and implemented. If the problem can be used properly, then the problem problem can be made a potential. The possibilities and problems raised in research must be supported by empirical data. Data on possibilities and problems need not be investigated alone, but must be supported based on investigative reports by others or with data or facts.
2. Collecting Data or Information
   The next step after the potential and problems are found, is to collect various information as material for planning specific products that are used to solve these problems.
3. Product Design
   The products produced in R&D research vary according to their respective fields. The end result of this research is a new product design, complete with specifications.
4. Design Validation
   Design validation is an activity process to evaluate product designs. Validation is still an assessment based on rational thinking, not local facts. This design validation can be done with reference to several professionals or experienced to evaluate the newly developed product. Each expert or expert will be asked to evaluate the design in order to better identify strengths and weaknesses.

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5. Design Revision
   Design revisions are made after validation is complete. Design revisions are carried out in accordance with the weaknesses that have been obtained previously in order to improve existing product designs.
6. Product Trials
   This stage is carried out with simulation or experimental activities in limited groups. Product trials are carried out with the aim of obtaining information when using the product being developed.

The preparation of electronic Student Worksheets with a realistic mathematics education approach begins with determining the learning materials to be used. Making and implementing student worksheets is done using the Articulate Storyline application. Then determine classes that can be used as research subjects by adjusting the learning time for students, as well as appropriate learning materials. After the material to be studied is determined, the researcher then compiles electronic Student Worksheets which uses a realistic educational approach to the specified material. Furthermore, the electronic Student Worksheets that have been compiled will be validated by experts or experts.

Data analysis technique

The data obtained in this study are quantitative data and qualitative data. Quantitative data is in the form of assessment scores by the validator which consists of a team of experts, namely material experts and learning experts, and student responses. Qualitative data in the form of responses and suggestions provided by the validator regarding student worksheets with the Realistic Mathematics Education (RME) approach that has been developed. Data analysis in this study is descriptive, where the data analysis technique is divided into two parts, namely:

a. Analysis for expert validation questionnaire results
b. Analysis for student questionnaire results

After all the questionnaires from experts obtained scores or responses, the data were analyzed using a Likert scale. The results of the questionnaire were analyzed using the following formula.

$$P = \frac{\sum f}{N} \times 100\%$$

Description: P = Category percentage

$\sum f$ = The total score of the selected category answers

N = Total score

Design validation is an activity that aims to evaluate product designs that have been done before. Student worksheet products that use a Realistic Mathematics approach that has been developed and validated by experts. This design validation aims to determine the limitations or deficiencies and advantages of student worksheets designed by researchers. These strengths and weaknesses help researchers develop higher quality student worksheets. The experts or validators in this study consisted of material experts (2 experts) and learning experts (2 experts).

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Result and discussion

Based on the questionnaire that was given to the team of experts, the results of the expert/material validator calculations from 2 experts who are mathematics lecturers on student worksheets with a validation score of 94.1% which is included in the very feasible criteria. Furthermore, based on the results of expert calculations/learning validators from 2 experts who are mathematics lecturers and mathematics subject teachers on student worksheets with a validation score of 90.6% which is included in the very feasible criteria. The expert team also provides input and suggestions to be used as material for consideration in revising student worksheet products. These suggestions have been made by researchers in an effort to improve the device to be developed.

Product trials

After revising the Student Worksheet which was developed according to the suggestions for improvement from the validator, the Student Worksheet is then tried out on students on a limited basis. A limited trial of the Student Worksheet product was carried out in two meetings. The trial of the Student Worksheet product begins with giving a presentation of the material because the type of Student Worksheet being developed is applicative-integrative. Previously the researcher distributed students in discussion groups, each group consisting of 4-5 people. Furthermore, the learning process is carried out by distributing Electronic student worksheets products online for students to complete. The time given to students to complete the Electronic student worksheets is approximately 50 minutes (1 credit) at each meeting.

Table 1. Results of electronic student worksheets answer analysis.

Group	Value of Student Worksheets at Meeting I	Value of Student Worksheets at Meeting II
Group 1	80	90
Group 2	80	90
Group 3	75	80
Group 4	70	80
Group 5	90	100
Group 6	80	90
Group 7	100	100
Group 8	85	85
Total Score	660	715
Average Total Score	82,5	89,4

Based on the table above, it can be seen that the average score at the first meeting of Student Worksheets was 82.5 and the average score at meeting 2 was 89.4. Then at the third meeting, the researcher conducted a learning achievement test on students to find out whether learning was able

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to make students understand the lesson. The study result test was carried out individually to 34 students because one student was not present.

Based on the tests conducted, it is known that of the 34 students who took the learning outcomes test, 32 students were in the complete category and 2 students were in the incomplete category. The highest score on the learning outcomes test above is 100 and the lowest score is 40. After the learning outcomes test was completed, the researcher then distributed student response questionnaires to 34 students. The analysis of student response questionnaires is as follows:

Tabel 2. Results of student response questionnaire analysis

That aspec rated	Indicator	Questions	
		Yes	No
Display of Student Worksheets	The appearance of the electronic student worksheet is very interesting so I am interested in reading it and working on it	100%	
	The presentation of the material fosters a sense curious about students	100%	
	The presentation of the material arouses interest me to read it	100%	
Presentation of Student Worksheets	The instructions in the electronic student worksheet are easy to understand	100%	
	The sentences in the electronic student worksheet are clear using standard and easy-to-understand language	100%	
	Illustrations shown in this electronic student worksheet is easy to understand	88,2%	11,8%
	The questions in the electronic student worksheets are easy to understand	94,1%	5,9%
Learning Component	The electronic student worksheets provide enough space so I can write and draw a thought on student worksheets	97,1%	2,9%
	The electronic Student Worksheet motivates me observing problem is provided	97,1%	2,9%
	Electronic student worksheets motivate me to ask questions	100%	

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	Electronic student worksheets motivate me to gather information	100%	
	Electronic student worksheets motivate me to reason	100%	
	Electronic student worksheets motivate me to draw a conclusion	100%	
	Electronic student worksheets motivate me to communicate	100%	
	Average	**98,3%**	**1,7%**

Based on the student response questionnaire table, it was found that the yes response was 98.3% and the no response was 1.7%. In other words, the electronic student worksheets developed by researchers on the criteria are very interesting because 80% or more students respond positively.

Conclusion

Based on the results and discussion of the research on the development of learning media that was stated earlier, the following conclusions are drawn.

1. Electronic Student Worksheets with the Realistic Mathematics Education (RME) approach meet the valid criteria with an average material expert validation score of 94.1% and an average learning expert validation score of 90.6% in very good criteria. In other words, Electronic Student Worksheets products developed using the Realistic Mathematics Education (RME) approach can be utilized in the field for learning activities.
2. The electronic student worksheets with the Realistic Mathematics Education (RME) approach meet the practical category because the results of the student response questionnaire showed that the electronic student worksheets developed were in good criteria with a yes response of 98.3% and a no response of 1.7%.
3. Electronic Student Worksheets with the Realistic Mathematics Education (RME) approach fulfill the effective category based on the aspect of effectiveness with an average score of 80.7 who have achieved learning mastery ≥ 75 and complete learning classically because 80% or more students complete learning individually (out of 34 students 32 of them finished studying and 2 students did not complete).

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The effect of using e-books to increase student's mathematics problem-solving ability

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Abstract. In this paper, we present a result of research on using the Flip Pdf Pro e-book to increase students' mathematics problem-solving ability in hybrid learning. The development, implementation, and evaluation stages were adopted from pseudo-experiments using 40 samples obtained from purposive sampling techniques. Used a one-group pretest-posttest design. This study aims to see students' mathematics problem-solving ability in learning which is measured directly through observation, which is facilitated by Flip Pdf Pro-based e-books, and find significant results after using Flip Pdf Pro-based e-books. It shows not only how they act to use the e-books but also how the e-books support them to learn. The study case treated them better in increasing their ability in solving a problem.

Keywords: E-book, mathematics problem-solving ability, flip pdf pro

Introduction

Hybrid learning is a learning method that combines online and face-to-face learning at the same time. This learning system is applied mostly in the post-pandemic period. However, the hybrid learning model significantly improves the advanced mathematical thinking of students and improves good relationships between students and lecturers [1]. Nonetheless, hybrid learning has a significant influence on improving learning outcomes. This learning model also provides a satisfying learning experience since it presents all the options for how to study [2,3]. It provides opportunities for students to learn in their own way anywhere and anytime and for lecturers to interact face-to-face complementing the learning process so as to achieve maximum results. A learning management system is used as a bridge to the interaction of lecturers and students in online learning. One facility which encourages hybrid learning.

Yet, not only need support by the learning system but how learning will go is also have to support by the learning equipment. It is the way to the responsibility to increase learning achievement and students' skills. In this article, we want to focus on students' mathematics problem-solving skills. Offering students with many conveniences, teachers create useful tools to

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be used. The use of *e-books* in the process of online learning provides easy access. Conventional teaching materials or printed teaching materials are considered less in line with learning models that apply the online learning process. Especially when the *e-book* is easy to access in online learning. The use of interactive *e-books* is considered effective in improving learning outcomes [4]. The results of a survey conducted by Gramedia Digital in 2019 stated that 85% of respondents prefer to use *e-books* compared to other media [5]. This is in line with the results of a survey conducted in January 2021 by Hootsuite for data in Indonesia, that users of technological tools in the form of laptops/computers amounted to 74.7%, *tablets* amounted to 18.5%, smartphones amounted to 98.2% of the entire population [6].

This model is a model with simple and ordered stages. This development is widely applied to the development of e-learning modules [7] ,learning media [8], and Interactive PowerPoint [9] which states that these media are suitable for use as learning media.

Flip pdf professional is a digital book-maker application. Its use through mobile learning can improve student learning outcomes [10]. Flip pdf pro is an interactive application where digital bookmakers can easily add various types of animative media types to the flipbook. With just drag, drop or click, we can insert youtube videos, hyperlinks, animative text, images, and audio and flash them into the flipbook. The text in the *e-book* built with this application can be customized to the convenience of the reader. The size of the writing is arranged in such a way that the weaknesses in the *e-book* can be neutralized and even add to the advantages of its own use. The ease of access that can be used on gadgets makes the most compelling reason for the user.

Literature review

Hybrid learning

The Covid-19 pandemic requires the teaching and learning process to be carried out online. This forces teachers and students to be technologically literate. This online learning process has been able to make teachers in this case lecturers use technology to support the learning process. Not only teachers but students are also forced to adapt to the online learning environment. The evaluation stated that the use of online applications, social media, and e-learning applications is used and applied complementarily in order to create good interaction between teachers and students. But all the issue is not without obstacles, unstable networks, supporting tools such as laptops or smartphones, and internet quota are still obstacles [11]. These problems are also the cause of the ineffectiveness of online learning. Students do not understand the material clearly [12]. Researchers, both teachers/lecturers, must find ways to maximize the learning process. But all these problems may be overcome if you have the opportunity to face-to-face learning. The reason is not all problems can be solved by online learning.

Along with the decreasing rate of the spread of Covid 19, post-pandemic learning can be done with face-to-face learning and online learning or known as blended learning. The learning process in blended learning is almost the same as the situation in the hybrid learning process. The blended learning process is learning that combines direct learning and online learning while hybrid learning is composing blended learning and computer-based learning. In the United States, hybrid learning is not new learning and is the most frequently used learning process. With various ways of implementation, hybrid learning provides opportunities for teachers as well as teachers to control the speed, time, and place of learning, so that both parties have the same responsibility for the learning collaboration that is applied [13].

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To support this learning process, media needed to be arranged in harmony with this learning process. One of them is to align teaching materials so that they are integrated with the learning process used. The use of e-books as a complement to printed teaching materials is a part of the media that must not be separated

E-book

Technology presents so many conveniences for humans. With technology, convenience, practicality, and creation can be obtained at once. And as it should be, the world of Education feels the benefits of this technology. Teaching materials as a very important part of the learning process do not go unnoticed by educators. The development of teaching materials from physical books to digital books/e-books provides convenience for teachers/lecturers in providing material. Interactive digital books are a solution for people who don't like to read physical books. Digital books must have six aspects of reading engagement namely affective, creative, interactive, joint, continuous, and personalized engagement [14]. Moreover, high-quality digital books are proven to be able to help children learn and enjoy reading by optimizing the design and reminding them that reading is the most important activity for children to learn [15]. But not everyone likes digital books/e-books, the survey results state that physical books have their own beauty. Therefore, the existence of digital books is not to replace the existence of physical books but rather to provide another look and reading atmosphere that is different from reading physical books. Due to the different ways of reading and the technology applied to digital books with all the suitability applied to the digital book, their application is also adjusted to the learning process. In this case, the e-book is designed to align with the hybrid learning process.

Along with the times, also driven by increasingly creative human abilities, there are many *e-book* maker applications that can be learned, obtained for free, and used easily. Of the many book-maker apps, flip PDF Professional is an interesting app to use. Digital books/ *e-books* developed using the flip pdf pro application can be used to improve the science literacy of learners [16]. Teaching materials developed using the Flip PDF Pro application are also declared valid for use as learning media [17]. But each application has its own advantages and disadvantages. The advantages and disadvantages of the Flip PDF Professional application are summarized in the table below:

Table 1. Pros and cons of flip pdf professional

EXCESS	DEFICIENCY
1) Interactive publishing. With an attractive appearance, adding videos, images, links, and more makes the flipbook interactive with users; 2) There are various templates, themes, scenes, backgrounds, and plugins to customize the e-book you want to create; 3) E-books can be supported with text and audio; 4) Flexible output (output) format, such as HTML, exe, zip, Mac App, mobile version and burn to CD.	1). Use can only be done on gadgets that support the flash feature. 2). There is no marker tool to mark which pages have been read. 3). Requires careful planning and a long time in modifying the media.

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Methodology

This study uses research and development methods with the 4D development model with the Define, Design, Develop, and Disseminate steps. As for this research, the steps taken are:

1) Define.
   At this stage, the steps are:
   a. Front-end analysis. At this stage, an initial diagnosis is carried out to find problems and think of solutions to increase the efficiency and effectiveness of learning.
   b. Learner analysis. At this stage, the characteristics of students are analyzed to see the absorption and motivation of students,
   c. Task analysis. At this stage, the lecturer analyzes the competencies that must be mastered by students
   d. Concept analysis. At this stage, the lecturer analyzes the strategies and steps that will be taken in learning
   e. Specifying instructional objectives. At this stage, the lecturer determines the learning objectives and expected changes from the learning
2) Design.
   At this stage, the steps are:
   a. Constructing criterion-referenced test, namely compiling a pre-test to determine the student's initial abilities and also as a prototype evaluation tool after the end of learning
   b. Media selection to choose learning media that is in accordance with the material and characteristics of students
   c. Initial design to simulate the presentation of material with media and learning steps that have been previously designed. During the learning simulation, peer assessment was also carried out.
3) Develop.
   In this stage, we have to do:
   a. Expert appraisal, which is to validate or assess the feasibility of the product design. In this activity, an evaluation is carried out by experts in their fields. The suggestions given are used to improve the materials and learning designs that have been prepared.
   b. Developmental testing, namely testing the design of teaching materials on the real target subject. At the time of this trial, response data, reactions, or comments were sought from the target users of the model. The test results are used to improve teaching materials. After the teaching materials are repaired then they are retested to obtain effective results.
4) Disseminate.
   In the last step, at this stage, researchers have distributed e-books as current teaching materials
   used in the Statistical Methods course in 3 classes in learning in a hybrid manner.

Results and discussion

Results

The purpose of this research is the development an e-book that we had created that can increase the problem-solving skills of anyone, especially students, that read and learn using the e-book. Using these 4D phases which are:

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Define Phase

a. Initial analysis (Front-end Analysis).
   For the first step, we analyzed the condition of how the student learns with hybrid learning. And found out that they have a few difficulties, such as having problems in their way to bring books, their lack of reading, and their understanding by reading only.
b. Learner analysis
   The next step in this stage is the analysis of learners. Students had been given a questionnaire to analyze their ability in solving problems. And the data obtained from the questionnaire
c. Task Analysis
   In the task analysis step, referring to the current curriculum, namely by using 6 KKNI tasks, students' mathematical problem-solving skills had been encouraged by providing work independently that students have to work on. This aims to discipline students' learning methods which will greatly support the improvement of students' mathematical problem-solving skills personally.
d. Concept Analysis
   This analysis aims to determine the content of teaching materials in the form of *e-books* that will be compiled. Prioritizing the presentation of understanding and analysis of problems based on case studies presented in the form of sample questions and the right flow of thought so that the problem-solving process can be resolved correctly.
e. Formulation of learning objectives
   The formulation of learning objectives is adjusted to the achievements of the courses. The e-book was created based on the ability that this research aims for. All the topics have to be based on the syllabus. It is necessary to emphasize the achievement of learning goals so that students have a strong learning foundation in particular. Hopefully the strains of why the student lack problem-solving skill could be covered by equipping the e-book with learning videos that can be seen directly.

Design Phase

a. Preparation of standardized tests.
   The standard test conducted after expert validation allowed and decided that all the tests had covered all the indicators of learning achievement. The test is also designed for looking up students' problem-solving skills. The essay tests had been chosen to show the achievement of the skills.
b. Media Selection
   To create satisfying media to stimulate students' desire of reading, flip pdf pro had been applied to present the material equipped with videos, and a lot of examples from various cases.
c. Initial design
   The e-book is designed to be used not only in android but also accessible on a laptop/pc. Provided the answer key to the assessment, the e-book is designed to help students increase their problem-solving skills.

Develop Phase

a. Expert assessment
   The expert validation of the design and the content had been taken and allowed the e-book as a learning media.
b. Trial

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The trial was carried out with 40 students.

The student had been treated by hybrid learning using e-books as the learning media. Furthermore, after the treatment, the students got their post-test and had been analyzed with Hypothesis:

H_0: $\mu_1 = \mu_2$, there is no significant difference between the average pretest and posttest values

H_a: $\mu_1 \neq \mu_2$, there is a significant difference between the average pretest and posttest values

From the data we got, the significance of Levene's test score is 0.663. This is greater than the significant value at 0.05, which means that both data are homogeneous.

Judging from the results of Sig(2-tailed) of 0.000 which is worth less than 0.05, which means rejecting and accepting which H_0 means that there is a H_a significant difference in the mathematical problem-solving ability of mathematics students after use of *e-books* given in this study.

Disseminate Phase

Where in the development stage, a formative evaluation is carried out, then at this stage a summative evaluation is carried out. In this phase of testing, validation should be carried out in real situations and involve many heterogeneous parties. The product must also undergo a professional examination in order to obtain an objective opinion about its adequacy and relevance. The ready product is then carried out in final packaging. The final stage is diffusion and adoption where manufacturers and distributors must be invited to work together to package the product in an acceptable form and market it widely. Special efforts are needed to distribute materials widely to encourage product adoption and utilization even though there are many digital channels currently available. At this stage, researchers have distributed e-books as teaching materials that are currently used in the Statistical Methods course in 3 classes.

Discussion

Hybrid learning has its own difficulties when learning takes place. Corrections to students' abilities, especially students' problem-solving abilities. It can be seen from the results of the research that has been presented above, that there are difficulties that arise when entering into problem-solving. When students receive the material, no significant difficulties arise to interfere with the learning process. This is because students who study in the classroom are still there. Difficulties arise when learning requires communication between students if grouped and interaction between students is online and face-to-face. While students' understanding of problem-solving concepts needs to be known even with the aim of improving them. That's why a teaching material is designed that can be used to improve problem-solving in statistical methods courses. The difficulty found is that almost all students do not solve problems according to the flow or stages in solving the problem. There are some who even misinterpret the problem. Most students are able to solve problems until they get the right answer but go through several stages that should have been passed. For example, when drawing conclusions after hypothesis testing. Conclusions are based on the results of the p-value only. Though there are other stages that should also be used in drawing conclusions. The number of skips on this problem is because working on this process takes time and an even longer process.

The stages of developing teaching materials are carried out with the aim of being able to improve students' problem-solving skills. Designing an e-book by containing learning videos, and examples of varied questions is a component of the book that is the advantage of this e-book.

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The initial learning video, which was designed to be a material explanation video, turned out to be less able to improve problem-solving skills. This is because students' understanding is better handled with explanations during class. But in the learning process itself, they tend to need help in solving problems. So, a revision of the e-book that has been tested is carried out. Improvements are focused on the goal of helping to improve students' solving skills, namely in the linked video, which initially contains material for understanding converted into a video that presents how to solve a problem. In this section, the needs of stakeholders are a concern.
But the help from the video is also supported by examples of the questions discussed in the book. According to the results of the questionnaire and the final evaluation carried out, most students stated that the presentation of sample questions is very helpful for students in identifying problems, so there was no error in interpreting the problem. If the interpretation of the problem is erroneous, then drawing conclusions will not correspond to what it wants to achieve. Changes in the content of the video and the addition of sample questions in the book are liked by students. This is in line with the conclusion of the hypothesis which states that there is a significant difference between the average rata-pretest results before using the e-book and after the treatment is applied.

Flip Pdf Pro is an application that makes it easy and feels very helpful in meeting the needs for ease of access, the practicality of use, and unobtrusive appearance but helps students in its use. Can be accessed at any time via the internet network if the device where this application has been installed is not affordable.

An important focal point in this e-book is that a given e-book must contain elements that are right on target. In this case, improving problem-solving skills is related to problem identification, problem-solving procedures, and decision-making processes for problems, and cases that occur in the community or stakeholders become the focus of the development of this e-book. Whether this e-book will be able to improve the problem-solving skills of e-book readers who are not students who have been given an understanding of the material in the classroom, has not been able to infer. More research is needed. Because the reader can open the student, it can be a practitioner or anyone who needs understanding and examples of cases in solving problems on the topic of the method statistics. This e-book is designed according to the meter of mathematics statistics courses, ranging from data recognition, population, opportunity, opportunity distribution, hypothesis testing, correlation, and simple regression, and only comes down to multiple regression. For the next topic, further research will be carried out which is a follow-up to this research.

Conclusion

From the research activities that have been carried out, a mathematics practicum learning design was produced using a Flip Pdf Pro-based e-book to increase student creativity. This design is applied to a digital book that has carried out product validation, namely material validation and media validation. The validation results are both in the valid category which means they are worth using. The e-book developed received a very good response from students who have studied using this e-book with a student response percentage of 85.54%, with reference to the level of practicality, it falls into the "very practical" category. Based on the test given, all students are complete in learning, where the lowest score is 84 exceeding the minimum completion limit of 80 with an average class score of 88.58. Thus, based on the completeness score of the test conducted by students, the e-book introduction to mathematics methods based

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on Flip Pdf Pro has proven to be effectively used in the learning process of student hybrid learning methods.

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Digital literacy-based module to enhance students' online self-directed learning

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Abstract. *In previous research, the author has developed a self-directed learning questionnaire for students in the Mathematics Department at previous study. After the questionnaire was used and received responses from 90 students of the Mathematics Department, the results were not satisfactory. The results based on the analysis of students' online self-directed learning are at level 6.95 with a maximum level of 10. This result need to be considered because self-directed learning from skills is needed by students not only in competency training but also as a provision for Unimed graduates in creating job competitions. Digital literacy-based module to enhance students' self-directed learning in courageous learning at the Basic Statistics course. Development of modul using 4-D model with phases; define, design, develop, and disseminate. At the define phase, it has been done; early-late analysis, student analysis, basic statistical concept analysis, task analysis in accordance with KKNI-based assignments, and formulation of learning outcomes. At the design phase obtained; the result of the preparation of modul and the results of the initial design of modul on the LMS Sipda platform until finally prototype I was obtained. At the development phase it was obtained; the test results of the validity of modul, effective results after field trials, and the results of self-directed learning questionnaires on students' courageous learning. After this stage, prototype II was obtained from digital literacy-based modul that were valid, effective, and able to enhance students' online self-directed learning.*

Keyword: Digital literacy, basic statistic module, online self-directed learning.

Introduction

The distance learning process at the college level received positive reaction. The level of mental maturity and students' self-directed learning was considered in accordance with the implementation of online lectures. State University of Medan has even conducted online lectures since the launch of the Sipda Learning Management System (LMS) in 2018. So that when the middle of the even semester of the 2019/2020 Academic Year which forces all lectures to be carried out online and face-to-face virtually, Unimed lecturers, students, and staff have become accustomed to this. Unimed has been trained and ready to carry out online lectures during the pandemic.

The implementation of online lectures requires a high level of student learning independence. Self directed learning is a conscious process of changing knowledge, skills, and attitudes towards

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one's own desires independently without relying on others [1]. Self-directed learning also emphasizes students' responsibility in mastering the material and achieving the learning outcomes as well as full control of students in determining learning patterns and styles outside the classroom [2]. A perfect LMS still cannot guarantee superior mastery of learning outcomes by students. There are other learning behavior factors that affect student learning outcomes, namely students' self-directed learning. Students must be able to determine learning resources that are relevant to learning outcomes and KKNI-based tasks. Although these learning resources have been provided by lecturers, students can determine the type of learning resources that best suits their respective learning styles. The implementation of online lectures narrows the lecturer's space to guide students in managing the completion of lecture assignments. Students are fully responsible for personal management in order to complete all KKNI-based tasks according to the schedule set at the beginning of the semester. The two reasons above, namely learning resource management and personal management are strong reasons why self directerd learning is very important for students to have.

The authors have developed an assessment of students' online self-directed learning for the Department of Mathematics in previous research. The research findings obtained at the implementation stage of the research and development revealed that the students' online self-directed learning of Unimed Mathematics Department students was at level 6.95 with a maximum of level 10. The display of the questionnaire results will be explained through Figure 1.

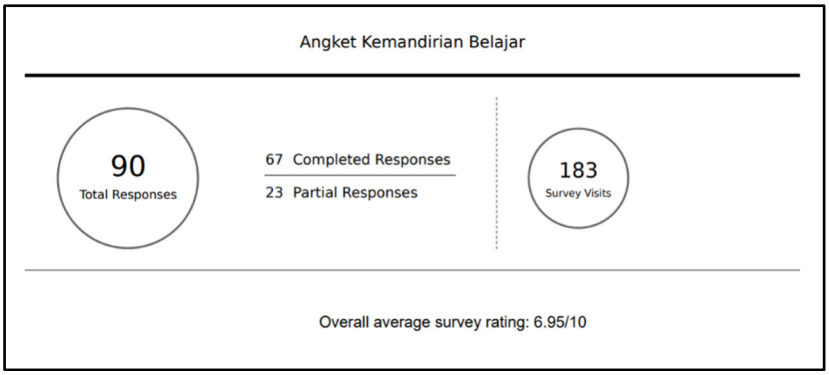


Figure 1. Result of students' online self-directed learning questionnare

Figure 1 above is the first sheet of the assessment report for the students' online self-directed learning questionnaire of Unimed Mathematics Department students in 2021 using Zoho Survey. The questionnaire was arranged in 30 questions and to ensure the consistency of respondents' answers, 30 items of negation questions were compiled so that there were total of 60 questions. The total respondents from 90 students who answered the questionnaire with 4 Likert scales showed an average result of 6.95 out of a maximum score of 10. Respondents were dominated by students from 2020 and 2021. More details are shown in Figure 2. This result, of course, cannot be said to be satisfactory because students from the two batches immediately undergo online lectures once they start studying at the Unimed Mathematics Department. If the condition of independent learning skills continues like this, it is feared that it can affect various aspects of

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students' soft skills, ranging from low personal responsibility, weakness in building networks digitally, to lack of creativity in the world of work competition.

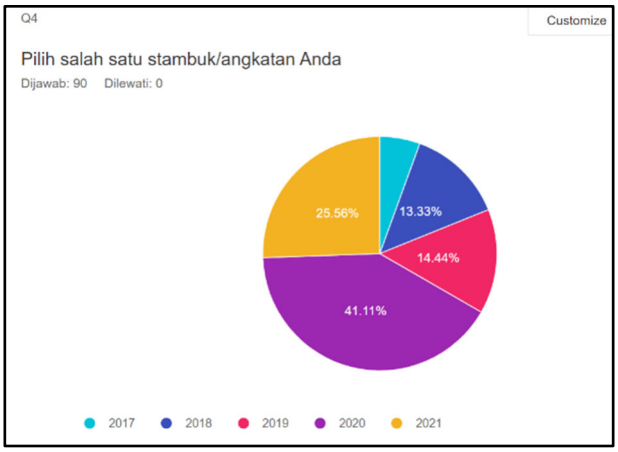


Figure 2. Result of Students' online self-directed learning questionnare

One of the items of questionnaire questions that consistently scores low is "I don't need to collect facts and information about the subject matter, just rely on friends and others" and also the question item "I find it easier to understand the lesson concepts from printed books than laptops/devices digitally". The two items are part of the fifth questionnaire indicator, namely; utilize and search for relevant learning resources. Seeing this awkwardness, the author offers an increase in the culture of digital literacy to eliminate the factors causing the low of self-directed learning.

The term digital literacy is a person's ability to use computer devices to access various information in the digital space [3]. Digital literacy is the tendency, attitude and skill of each person in utilizing computer informatics technology (ICT) tools in collecting, managing, analyzing, evaluating information and to build new ideas and communicate with other individuals effectively [4]. Given the importance of digital literacy in determining student learning success, digital literacy skills need to be developed in order to face the era of the industrial revolution 4.0.

Efforts to improve the culture of digital literacy for students can be done in various ways. One of them is by designing teaching materials based on digital literacy. Teaching materials that are arranged innovatively in various formats so that they are more interesting and dynamic, will motivate students to be more meaningful in learning [5]. Digital literacy-based teaching materials will develop students' habits in finding, filtering, and analyzing ideas and ideas from various information sources available digitally independently. So that students will have a high responsibility for the lecture process they experience. This will have a positive impact on student learning independence. Based on the explanation above, the author will develop digital literacy-based teaching materials to increase students' selfdirected learning. The author chose to develop teaching materials for the Basic Statistics course because this course is studied by all students at Unimed as a provision for completing the final project, especially students in the Mathematics Department.

Literacy is the ability of individuals to process various information and ideas necessary to solve life problems. Initially digital literacy was the ability of a person to utilize computer devices to

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obtain various information in the form of visual electronic transmission [3]. According to Bawden, digital literacy is more about a person's technical skills in operating information technology devices to access, understand, analyze, assemble, and disseminate information digitally [6]. Furthermore, now digital literacy is not only about how to process information digitally but also how to carry out daily activities utilizing electronic information technology tools. Digital literacy can be interpreted as a person's awareness of the role of information technology in digitizing various things encountered in everyday life.

Before the Sars-cov 2 virus spread between countries, the Ministry of Education and Culture Indoneisa through the socialization of Literacy Support Materials had emphasized the importance of digital literacy in the Education curriculum. The success of building digital literacy is one of the indicators of achievement in the field of education and culture because it will create a community order with a critical-creative mindset and outlook [7]. According to Hague & Payton, there are eight elements of digital literacy in the realm of educational curriculum, namely; (1) Functional skills and beyond, related to students' basic skills in operating information technology devices; (2) creativity, about students' thinking creativity in their interaction with information technology devices to build the necessary ideas and ideas; (3) collaboration, related to the ability to collect information and cooperate with other students through digital public space discussions; (4) communication, an element of how students listen, understand, and convey ideas digitally; (5); The ability to find and select information, this component is about the ability of students to determine digital learning resources and select their correctness; (6) critical thinking and evaluation, related to how students think critically about materials and tasks in terms of achieving curriculum competencies and conducting digital evaluations of the learning process they have gone through; (7) cultural and social understanding, related to the elaboration of the experiences of students from different community groups and cultures; and (8) e-safety, which is the safety of digital exploration from cyber intrusions and criminal acts [8].

Students' self-directed learning means the ability of students to carry out learning activities with confidence and confidence without help from friends or others. Students are responsible for decision-making related to the learning process and have the ability to carry out those decisions. Self directed learning is one form of expected student learning behavior. Self directed learning is the behavior of the student in his will and desires in a real way and not dependent on others. Operational self-directed learning can mean that students are able to learn on their own, are able to determine the sources and teaching materials, are able to determine their own learning methods and styles, and are able to divide their own time.

Critical thinking skills, an attitude of responsibility, and hard work are shaping behaviors in students' self-directed learning. Ratnaningsih reveals three phases in self directed learning, namely; (1) forethought, the stage of task analysis and setting the desired goal; (2) performance control, the process of controlling actions, cognitive, attitudes, emotions, and motivations that can affect performance; (3) self reflection, related to considering what has been achieved and the possibility of changing orientation or goals if necessary [9]. The student's online self-directed learning is intended to prepare students to search and analyze sources of information digitally and compile a frame of mind so that students can build concepts, ideas, and ideas independently. The student's online self-directed learning also forms the personal responsibility of students for assignments and the achievement of competencies that must be possessed.

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Murray Fisher and colleagues have put together a valid instrument to measure a scale of student's self-directed learning. The questionnaire instrument was analyzed using main component factor analysis with varimax rotation, Chronbach alpha coefficient, and item-to-total correlation to measure construct validity and reliability. Of the 75 questionnaire items they compiled, 42 valid questions were obtained [10]. Previous research authors have developed an online self-directed learning questionnaire for students in the Unimed Department of Mathematics adopting Murray Fisher's students' self-directed learning questionnaire. The questionnaire consists of 8 indicators spread into 30 positive questions and 30 negative questions. The questionnaire question items are shown in Table 1.

Table 1. Question of students' online self-directed learning

Indicator	No	Positive Questions	Negative Questions
Have a learning initiative	1	I enjoy the learning process	Even though I know learning is important but still a burden
	2	I love learning about new opportunities	I don't want to waste time learning things that are new opportunities
	3	For me learning is a necessity	Until now I am still trying to consider learning is a necessity
	4	I often think critically about developing new ideas in drafting a Student Creativity Program proposal	I prefer to just join in with the idea of a group friend in the PKM proposal
	5	I want to learn new things that support life in the future	For me it's enough to focus on the abilities needed to graduate from a particular course
Diagnosing learning needs	6	If I find a problem in a lecture I will draw up a plan for solving it first before solving the problem	I will solve the lecture problems I encountered in the fastest way possible
	7	I will independently understand the lesson and ask for help only when needed	I prefer group cooperation in understanding the lesson
	8	I am a typical person who is willing to listen to the advice of others	For me the advice of others will only add to the burden of the mind
Setting learning goals and objectives	9	I prefer to define the learning objectives of a course in my own opinion	I will follow the learning objectives of the course from lecturers or modules
	10	I am always improving my abilities in the field of information technology	I feel enough of my ability in the field of information technology
	11	I like to specify what ability criteria need to be improved	For me, if you want to learn new things, you don't need to think about whether it will be useful someday or not

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Monitor, organize, and Controlling the proces of learning	12	I was able to manage my time well	Usually I manage my time well but sometimes a lot of unexpected things happen
	13	I have good self-management skills	Until now I have tried to have good self-management skills
	14	I was able to focus on solving a problem	For me solving problems while playing is an interesting thing
	15	I'm the person responsible for everything I do	My principle of working on something is that it is important to be ready for the results
	16	I'm always strict about things that interfere with study time	I'm always flexible with my study time
	17	I prepare for focus times in learning	I used to learn sambal doing other activities
Utilize and search for relevant learning resources	18	The ideas and ideas of a science for me often change according to the reading material I learn	If I have mastered a concept there is no need to bother to read other reference materials for the same concept
	19	I am confident in my ability to get information from digital sources	I will easily get new information from friends or other people
	20	I like to find explanations of a concept from articles and videos on the internet	I find it easier to learn a concept if the source is a book/module
Choosing and establishing a learning strategy	21	I prefer to design learning in my own style without having to be directed by lecturers	I believe lecturers will direct good learning strategies in lectures
	22	I have always been systematic in learning	I will study anything according to the taste of my heart
	23	I always gather facts before making a decision	I always take quick decisions without gathering facts first
Engevaluation of learning processes and outcomes	24	I often think about why college students when studying in class feel easy while when exams feel difficult	For me, the main thing is to be able to answer the exam questions correctly
	25	I'm always learning from mistakes	I think wrong is common for a student
	26	I always expect feedback from lecturers for my work	I don't care about assessment feedback from lecturers as long as I get good grades
Appropriate Self Eficacy	27	When sandwiched with a problem that I really can't solve, I'll ask for help	No matter how difficult the problem I face I will not ask for help from friends or other people
	28	I always feel confident in my abilities	I always need the help of a friend or someone else because sometimes I am not sure of my own abilities

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	29	I know where my limits are	I always accept tasks even if I am not able to work on them
	30	I'm the one who thinks logically	Sometimes I think logically while keeping an eye on the state of affairs

Digital literacy is a skill for students to collect digital information in order to achieve competencies that must be mastered. Based on the results of previous research it was revealed that digital literacy-based teaching materials can improve communication skills and creativity in the era of revolution 4.0 by class IX students [11]. Meanwhile, the results of the study Fadila et al explained that digital literacy functions as a determinant of students' self-directed learning at UIN Sunan Kalijaga [12].

Methodology

In accordance with the explanation above, this study includes developmental research. Development research is oriented towards product development where the development process is described as accurately as possible and the final product is evaluated. The development process deals with activities at each stage of development and the final product is evaluated based on the established aspects of product quality [13]. This development research is carried out to produce teaching materials for basic statistics courses based on digital literacy to enhance students' self-directed learning.

This research was carried out in the mathematics department in the even semester of the academic year 2021/2022, more precisely during March 2022 to May 2022. The subject of this study is a student of the Department of Mathematics in the fourth semester who takes the Basic Statistics course. The object of this study is teaching materials for digital literacy-based Basic Statistics courses accessed by students through Sipda (LMS of State University of Medan)

Result and discussion

Result

Phase Define

The results of this phase obtained early-end analysis, student analysis, concept analysis, and task analysis. The following will describe the results of each sub-sphase.

End-to-end analysis. Based on the author's experience and observations during the Basic Statistics course, there is no teaching material that contains supporting elements towards student digital literacy. This is a condition that is not ideal considering that the last four semesters almost all lecture activities were carried out online due to Covid-19. For example, when the online lecture method requires a student discussion process, students display the results of the discussion without showing the process. This happens because there are no detailed instructions on how online discussions are carried out also due to the limitations of the supporting application.

Student analysis. Medan State University has provided a LMS platform called the Online Learning System (Sipda) so that online lectures that have been running for the last 2 years should not encounter obstacles. Student learning outcomes have not changed significantly when implementing online lectures, but students' online self-directed learning was included in the sufficient category, especially in students majoring in mathematics.

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Concept analysis. Basic Statistics is a course that studies the application of descriptive statistics commonly used in qualitative research. This course is a prerequisite course before students get the Inferential Statistics course which is commonly used in quantitative research. This course studies about; statistical data, data presentation, data centering measures, data dissemination measures, data collection techniques, and applications of descriptive statistics in mathematics education research.

Task analysis. The assignment system used is six KKNI-based tasks, namely; Routine assignments in the form of quizzes that are done directly by students individually at the end of the meeting; Critical Journal Review, is the task of an individual who reviews a descriptive research scientific article published in a scientific journal; Critical Book Report, the task of comparing 2 books where there is one main book used by all students and another book chosen by students which is one of the reference books of articles on the Critical Juornal Reivew assignment related to Statistical Methods; Engineering of idea, is a student group task that aims to train students in exploring an activity (event) which is designed to be an activity derived from the PKM proposal prepared by students; Mini Research, an assignment in which students explore the culture of digital literacy among students of the Unimed Mathematics Department by compiling questionnaires and interviews then taking data and then analyzing and reporting the results of the research; and Project, where students arrange activities as an effort to improve student digital literacy culture based on research results that have been found in Mini Research assignments.

Phase Design

The results of this phase obtained the preparation of the self-directed learning questionnaire, the preparation of draft teaching materials, and the initial design in LMS Sipda. So that the first prototype (prototype 1) was obtained from teaching materials for Basic Statistics Based on Digital Literacy.The following will describe the results of each sub-phase.

Preparation of online self-directed learning questionnaires. The questionnaire consisted of 30 positive questions and 30 negative questions for a total of 60 questions. The indicators of the self-directed learning questionnaire are; have learning initiatives, diagnose learning needs, set learning targets and goals, organize and control the learning process, utilize and search for learning resources, select and establish learning strategies, evaluate learning processes and outcomes, and appropriate self-eficacy.

Preparation of draft teaching materials for Basic Statistics. The preparation of draft teaching materials is carried out in accordance with the learning outcomes of Basic Statistics. The material in the draft teaching materials is as follows; Basic Concepts of Statistics, Statistical Data, Data Presentation, Data Centering Measures, Data Dissemination Measures, Populations and Samples, and Research Hypotheses.

Preparation of basic statitic teaching materials based on digital literacy. Digital literacy-based teaching materials can be accessed by students on the LMS Sipda platform. The following is screen capture of teaching materials on Sipda in Figure 3 and Figure 4 and the emphasis on Digital Literacy is found in each Chapter as shown in Figure 5.

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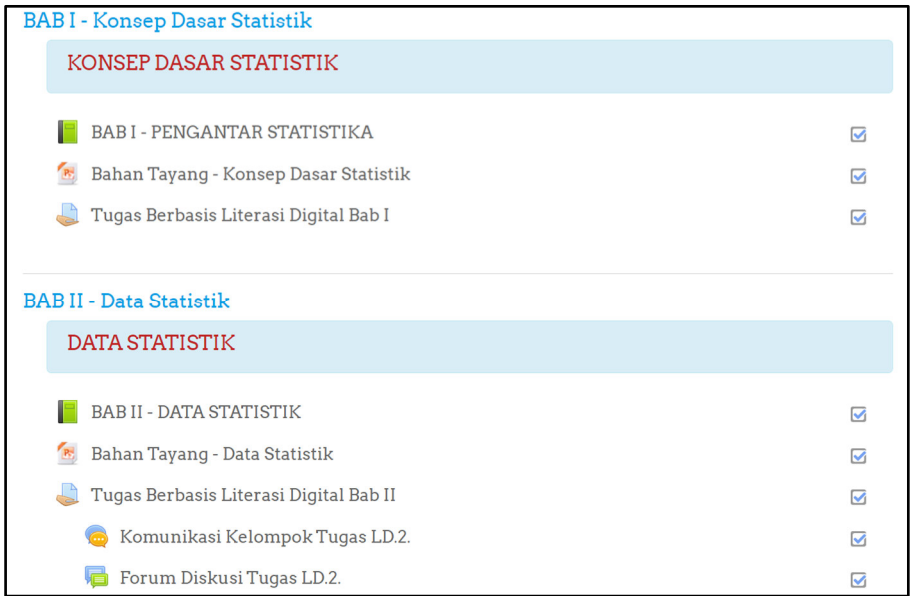


Figure 3. Screen capture of teaching materials on LMS Sipda



Figure 4. Content of teaching materials on LMS Sipda

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Figure 5. Emphasis in digital literacy is found on each chapter teaching materials

Phase Develop

The results of this phase are obtained expert validation, field trials to see the practicality and effectiveness of teaching materials, and the results of students' online self direcrted questionnaires. The following will describe the results of each sub-phase.

Validity of Digital Literacy-Based Teaching Materials. Digital literacy-based teaching materials have been validated by 2 Mathematics Education lecturers and a Computer Science lecturer. Validation of teaching materials includes 10 indicators, namely; Language structure, material content, functional skills and beyond elements, creativity elements, collaboration elements, communication elements, elements of the ability to find and select information, elements of critical thinking and evaluation, elements of cultural and social understanding, and elements of e-safety. The validation assessment is said to be valid if the validation mean (V_n) is at intervals of $4 < V_n < 5$. The average score of the three validators is 4.23 so that the Basic Statistics teaching materials can be declared valid. A summary of the validation scores of the three lecturers is presented in the Figure 6.

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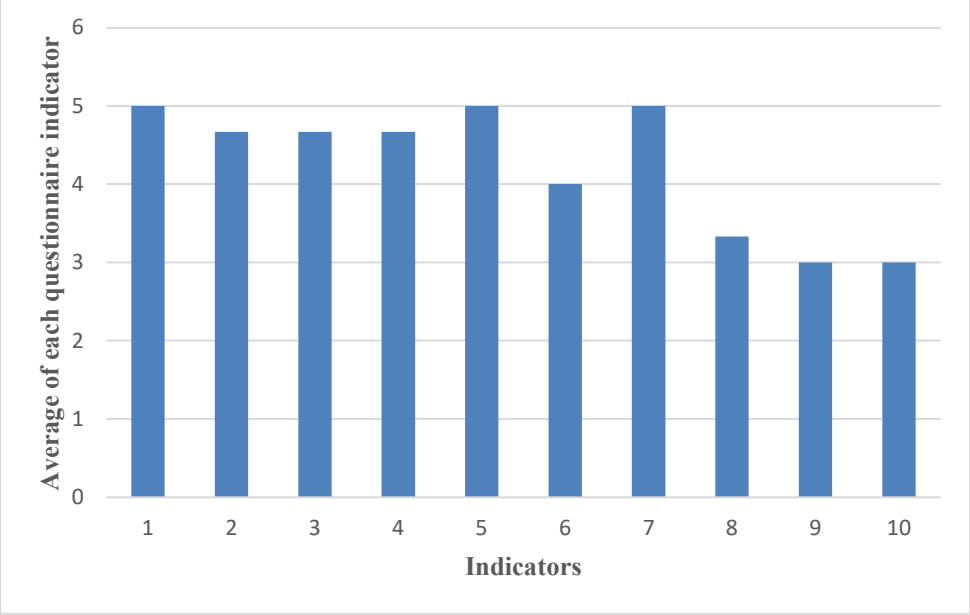


Figure 6. Validation score average from three lecturers

Effectiveness of Teaching Materials. The effectiveness of teaching materials is seen from the appropriate use of teaching materials in the Basic Statistics course after being tested. From 38 students who took the Basic Statistics course in the PSPM 20-D class, 34 students got grade A, 3 students got grade B, and 1 student got C grade.

Results of the Students' Online self-directed learning Questionnaire. Students' Online self-directed learning Questionnaire was given to 38 students and an average questionnaire score of 3.63 was obtained. The value of this questionnaire has increased from the previous average with a score of 2.78. The initial guess was that the self-directed learning in mathematics majoring in mathematics enhancing through the use of basic statistics teaching materials based on digital literacy.

Phase Disseminate

At the phase disseminate, a wide distribution of teaching materials is carried out. However, in this study, the distribution in question is to disseminate the use of digital-based teaching materials to other parallel classes that take Basic Statistics courses, namely the PSPM 20-C, PSPM 20-E, PSPM 20-F classes. In total there are 4 parallel classes in the Mathematics Education study program that use Digital Literacy-Based Basic Statistics teaching materials.

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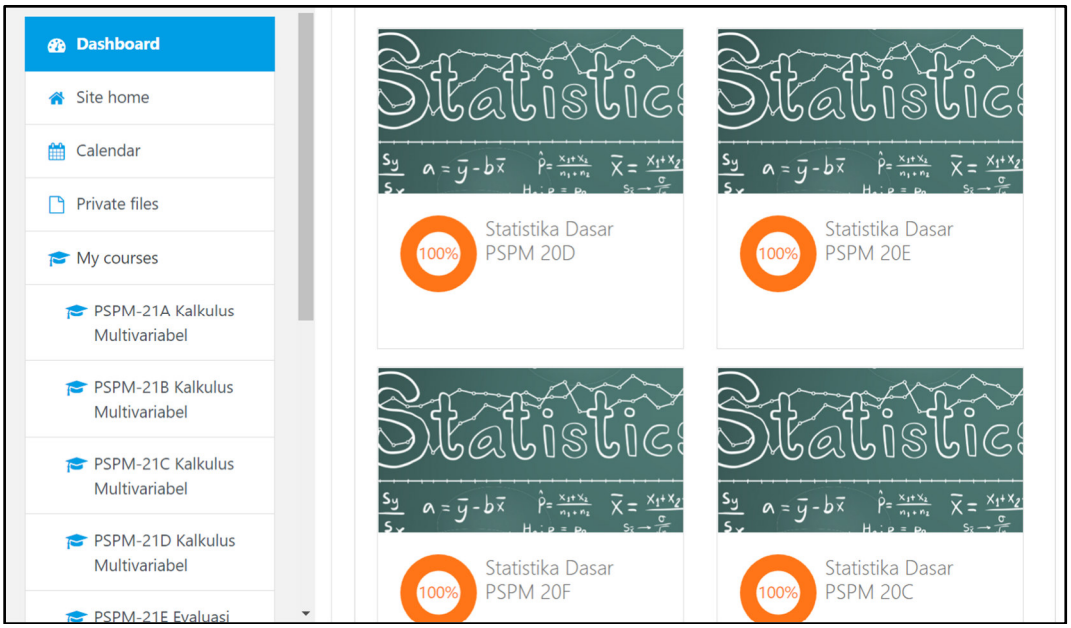


Figure 7. Digital literacy-based teaching materials use in 4 parallel classes

Discussion

Students are more active and confident in discussing formally in the discussion forum menu and informally in the Chat menu. Researchers always give feedback on students' posts in the discussion forum menu but never comment on the chat menu, even students thought researchers were not join on the chat menu. Because students thought researchers were not join on the chat menu, they communicated with their language style. Although the topic of discussion on the chat menu could be often off track, but many creative ideas arise spontaneously from students. From the silent monitoring, of researchers, recorded many ideas from students first appeared in the chat menu. Then the ideas were commented on and criticized by their friends. After refining these ideas, then students post these ideas in the discussion forum menu. It can be assumed that students feel comfortable making comments, criticisms, and creative ideas when lecturers are not directly involved in communication with fellow students.

There is an indicator of online self-directed learning questionnaire that is coherent with the research findings above, namely appropriate self-eficacy. Although judging from the raw data of 38 students who were measured by their self-directed learning skill, no extreme scores were found in the last indicator of the questionnaire. This is a researcher's question that needs to be found immediately. Why for the appropriate self-eficacy indicator, students find high self-confidence but are not stated in the questionnaire they answer. Hopefully, this question will be answered in the next study.

Conclusion

The conclusion obtained to this stage is that the preparation of teaching materials that use 4-D has gone through the phases of define, design, develop, and disseminate. Prototype II teaching materials for the Digital Literacy-Based Basic Statistics course have gone through validity tests

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and effectiveness tests. Basic Statistics teaching materials based on Ditigal Literacy can also increase the independence of online learning of Unimed Mathematics Department students.

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Feasibility test of micro learning-based digital modules in association and logic courses

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Abstract. *This research was carried out with the aim of knowing the feasibility level of micro learning-based digital modules in assembly and logic courses in the 2022-2023 academic year. This study uses a quantitative method with testing procedures used are Alpha Testing and Beta Testing. The subjects of this study were students of the Mathematics Education Study Program, FMIPA UNIMED, to be precise students in the PSPM DIK-E and PSPM DIK F 2022 classes. The data collection technique was carried out by giving validation questionnaires to material experts and media experts as well as distributing response questionnaires to students as users of this microlearning-based digital module. Data analysis using quantitative data analysis. The research results obtained were digital modules based on micro learning in the set and logic courses received an assessment of 82.50% from media experts, 84.43% from material experts, and 85.16% from users or students. So it can be concluded that digital modules based on micro learning in the set and logic course are very suitable for learning in the Mathematics Education Study Program FMIPA UNIMED.*

Keywords: Digital modules, micro learning, sets and logic, feasibility test.

Introduction

The Covid 19 pandemic outbreak is increasingly unstoppable with a strong escalation in its spread across space and time on a wide and fast scale. Corona virus disease 2019 (Covid 19) has transformed into a pandemic and forces humans to limit the space for interaction between humans. Due to the impact of the pandemic for about two years, our students are spoiled by learning from home where the implementation is not optimal. Because not all students follow it well.

One of the impacts of the corona virus pandemic (covid-19) is the world of education. In Indonesia, positive cases of Covid-19 continue to increase. This caused educational activities in schools to be temporarily suspended and diverted to learning from home. Students are directed to

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carry out online learning from home until the Covid-19 pandemic passes. However, in various conditions, online learning is considered less effective because during learning the teacher cannot convey learning material to the fullest like in offline (face to face) learning.

Living in the 21st century is certainly different from living in the previous century, where technology is increasingly sophisticated and developing rapidly so that it affects all sectors of life starting from the world of education, economy, social and others. In order to survive and overcome existing problems, these individuals must have skills in the 21st century. One of the 21st century skills, namely learning and the ability to innovate includes critical thinking and problem solving, as well as creativity and innovation which requires individuals to be able to think and work creatively, and create new innovations to adapt and solve existing problems, so that the ability to think creatively becomes a basic ability that must be possessed by individuals in the 21st century [6].

Mathematics has become a field of science that cannot be separated from other fields of science, which is a basic science that has an important role in mastering science and technology. However, mathematics is a subject that is less liked by students because it is considered difficult and less attractive to students [1]. Students still have difficulty understanding material concepts due to lack of knowledge and teacher preparation in making and using learning media. One of the development innovations that can be carried out is to design a digital module that connects abstract mathematical concepts to be concrete through activities in learning, especially online learning.

In connection with the analysis of the needs of semester 1 (one) students in learning sets and logic courses, the innovation that can be done is to develop digital modules based on micro learning which reveals that the method that can be used to improve students' mathematical understanding through digital modules is to provide activities. The development of digital modules based on micro learning offers many things, including; (1) Hand out, (2), PPt for each meeting, (3), video motion graphics, (4) Set and logic e-book, (5) Practice questions distributed via google form. Therefore, the digital learning module that will be developed by this researcher is interactive, thus providing opportunities for students to be active.

According to Winarno [2], the things that are evaluated in the development of digital learning modules are as follows: (1) Subject matter, namely whether the material provided is in accordance with the initial objectives of making the program and the depth of the content of the material by looking at the suitability of the level of students who will use the product and whether it is in accordance with the objectives to be achieved. Is the content structure appropriate and appropriate to the material presented in the product? (2) Auxiliary information, is additional information that is not directly related to the material, such as introductions, instructions, assistance, and conclusions. (3) Affective considerations, namely how this module can motivate students to be more enthusiastic in learning. (4) Interface, product appearance is very important, so developers of digital learning modules must pay attention to writing text, animation and graphics, audio and video. (5) Navigation, navigation must be made as easy and clear as possible so that users or students do not find it difficult to access the designed program. Navigation must be consistent and efficient. (6) Pedagogy, things that must be considered are methodology, interactivity, cognitive abilities, cooperative learning, learning strategies, user control, questions, answering questions, quality of feedback, and level of mastery of the material. (7) Robustness or product resistance is needed. It is endeavored that the designed program never fails or errors.

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Microlearning is used as a strategy in designing learning content into small and focused segments. The intended content is in the form of learning objects used in e-learning. Examples of these learning objects include short videos (motion graphics videos or explanatory videos), infographics, pictures, articles, handouts, and even quotes. In Microlearning, long learning content can be presented in the form of one infographic and can even be made on one sheet or designed with short videos of 1 – 3 minutes duration. This is designed so that learning content is easily absorbed and remembered by students, and can even reduce student boredom in learning. Presentation with a microlearning strategy produces a short, efficient, practical and accessible type of content whenever and wherever it is needed. Microlearning is said to be able to make the learning process in e-learning more effective for 4 reasons namely; (1), learning content is made very small (Bite size) and short, so that other distractions outside the learning context can be diverted quickly so that students are more focused on learning so that the contents of the material can be well understood by students; (2) Specifically, the content presented is one theory with one example or practice according to the problems that are often encountered and according to the teaching material; (3) Presentation of fast and short content will result in short learning time, so that when accessed via a cell phone, a learning object can be understood quickly by students; (4), Adjusting the needs and conditions of students. Where, learning objects can be accessed again by students when needed.

Based on this description, a micro learning-based digital module feasibility test will be carried out in student classes taking assembly and logic courses. The formulation of the problem in this research is what is the level of feasibility of digital modules based on micro learning in sets and logic courses? And the purpose of this study was to determine the feasibility level of digital modules based on micro learning in sets and logic courses, both based on media aspects and material aspects.

Methodology

This research uses quantitative methods. The quantitative method is a research method based on the philosophy of positivism. This method is used to examine certain populations or samples by collecting data using research instruments in the form of validation questionnaires, statistical data analysis is quantitative, with the aim of testing the hypotheses that have been set [3]. This research was conducted at the Faculty of Mathematics and Natural Sciences, the Department of Mathematics, Medan State University. The subjects of this study were students of the Mathematics Education Study Program in the PSPM-22E and PSPM-22F classes. The object of this research is a digital module based on micro learning in the set and logic course.

In this study the testing procedure carried out was the Alpha test, where the testing was carried out in the validation test by media experts and material experts. In testing the questionnaire instrument items, namely in the form of a validity test and a reliability test. In the next stage, testing is carried out on the use of microlearning-based digital modules by conducting a Beta test. Data collection techniques were carried out by distributing questionnaires containing a set of written statements or questions given to respondents to answer [3]. The questionnaire used both for field trials and product quality testing uses a closed questionnaire model or in other words, answer choices have been provided for respondents to choose from.

Before the product from the microlearning-based digital module is used by research subjects, it is necessary to test the validity and reliability of the instrument first. Instrument validation is

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intended to ensure that the instrument that has been made is feasible to use and indeed measures what it is intended to measure. The reliability test was carried out after the instrument validation was completed. Reliability tests are carried out to ensure that the instrument has a consistent measure of what it should measure [4]. Validity test was carried out on each question item. The calculation results of r are compared with r table where df = n-2 with sig 5%. If the r table is smaller than the r count, the instrument is said to be valid. The validity test uses the Product Moment correlation technique using the following formula:

$$r_{xy} = \frac{n \sum X_i Y_i - (\sum X_i)(\sum Y_i)}{\sqrt{\{n \sum X_i^2 - (\sum X_i)^2\}\{\{n \sum Y_i^2 - (\sum Y_i)^2\}\}}} \ldots(1)$$

Information:

N : The number of data pairs X and
ΣX : Total Amount of Variable X.
ΣY : Total Amount of Variable Y.
ΣX^2 : Square of the Total Number of Variables X.
ΣY^2 : Square of the Total Number of Y Variables.
ΣXY : Multiplication Result of the Total Number of Variables X and Variable Y.

As for the reliability test using the Alpha formula, which is as follows:

$$r_i = \frac{k}{(k-1)} \left\{1 - \frac{\sum \sigma_b^2}{\sigma_t^2}\right\} \ldots(2)$$

Where: r_i : Instrument Reliability
k : number of statement items
$\sum \sigma_b^2$: number of item variants
σ_t^2 : total variance [5]

After the reliability coefficient is known, it is then interpreted using categories according to Arikunto [6], as in table 1 below.

Table 1. Table of interpretation of the value of r

Value of r	Interpretation
Between 0.800 to 1.00	high
Between 0,600 to 0,800	Enough
Between 0,400 to 0,600	slightly low
Between 0,200 to 0,400	Low
Between 0,000 to 0,200	very low

In this study the data analysis technique used is quantitative data analysis techniques. Data from the assessment results obtained from expert validators and material validators will be analyzed descriptively qualitatively and used as a reference for revising microlearning-based digital module products, so as to produce products that are suitable for use by students in assembly and logic courses. The product design developed was assessed by the validator using a validation sheet and all aspects measured were assessed using a Likert Scale. Likert scale is a number of positive or negative statements about the attitude object. The main principle of the Likert scale assessment is

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to determine a person's position in a series of attitudes towards the attitude object from very negative to very positive related to the product being assessed [4].

The next step will be an assessment of the feasibility test of microlearning-based digital modules to be implemented in sets and logic courses. Based on the data obtained from the weight of each response given, the average score will be calculated using the following formula:

$$\bar{x} = \frac{\sum x}{n} \ldots (3)$$

$\bar{x}$: average score
n : responden
$\sum x$: total score respectively

Then the yield percentage formula can be calculated using the following formula:

$$result = \frac{ttotal\ score\ obtained}{score\ maximum}\ x\ 100\%$$

The eligibility category is based on the following criteria [3].

Table 2. Product eligibility criteria.

No	Score (%)	Category 2ligibility
1.	< 21%	very ineligible
2.	21 – 40 %	not feasible
3.	41 – 60 %	fairly decent
4.	61 – 80 %	Eligible
5.	81 – 100 %	very feasible

Results and discussion

The research data was obtained from the results of completing a set of instruments in the form of a questionnaire given to two media experts, two material experts, and a number of respondents or students to assess the feasibility results of the developed micro learning-based digital module. Before the respondents filled out the assessment instruments provided, each respondent first tested the Interactive Learning Media in the set and logic courses that had been developed. The results of the validation test by media experts were in the form of responses and assessments from media experts, then the results of the data obtained were analyzed and product revisions were carried out according to the suggestions. The results of the data are shown in Figure 1 below.

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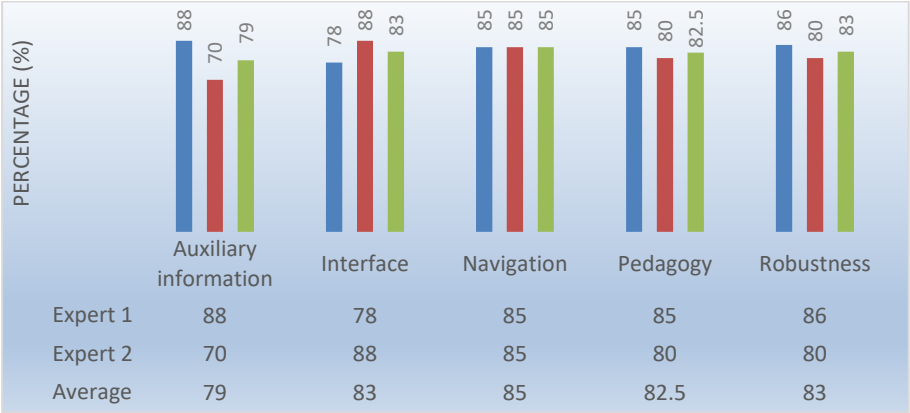


Figure 1. Percentage diagram of media experts

The results of the feasibility percentage of microlearning-based digital modules from two media experts are shown in Figure 1. Based on the Auxiliary Information aspect, an average value of 79.00% is obtained, the Interface aspect is obtained by an average data rate of 83.00%, the Navigation aspect is obtained by an average data value of 85 .00%, the Pedagogical aspect obtained an average data of 82.50%, and the Robustness aspect obtained an average data of 83.00%. The average value of the total percentage of the two media experts is 85.00%, in other words that digital modules based on micro learning in sets and logic courses are categorized as very feasible to use.

Assessments and responses from material experts are data from validation tests on the developed microlearning-based digital module products. Furthermore, this data is analyzed to determine whether or not the product developed is appropriate with the set and logic course material, and to find out what things need to be improved on the product developed according to the suggestions of two material experts. The results of the validation test data from 2 material experts can be seen in Figure 2.

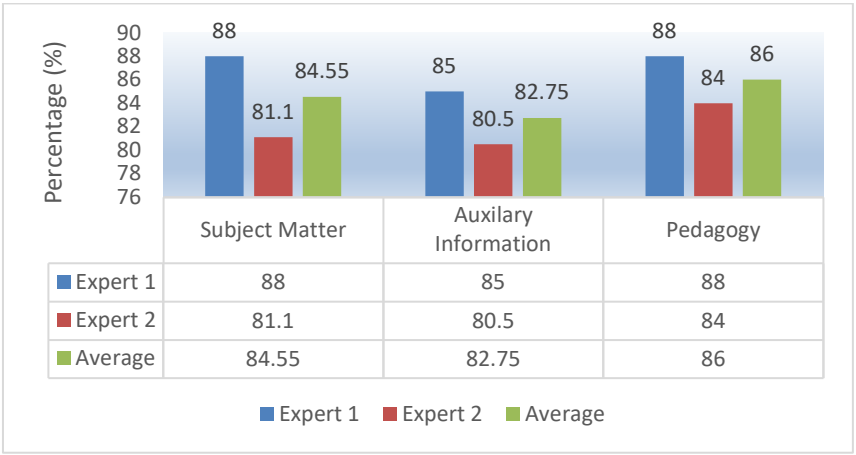


Figure 2. Percentage diagram of material experts

The results of the feasibility test of microlearning-based digital modules in terms of the suitability aspect of set material and logic can be seen in Figure 2. In the diagram, it can be seen

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that the average score based on the Subject Matter aspect is 84.55%, the Auxiliary Information aspect obtained an average data of 82 .75% and the Pedagogic aspect obtained an average of 86%. From the data reviewed based on these several aspects, an average percentage of the total of all aspects was obtained, namely 84.43%. It can be concluded that the microlearning-based digital modules developed are in accordance with set and logic course material and are categorized as very feasible to use.

The next stage was to test instruments on 30 students, namely in the PSPM-22E and PSPM-22F classes, in order to determine validity based on student responses after using microlearning-based digital modules in sets and logic courses. Then the data obtained were analyzed using the Product Moment correlation technique with the help of the SPSS application to find out whether each instrument item was valid before it was used for trial use. In this study reliability testing using internal testing. Reliability testing with internal consistency is carried out by trying the instrument only once, then the data obtained is analyzed using certain techniques. The results of the analysis can be used to predict the reliability of the instrument. The following is the Alpha formula used for reliability testing.

$$r_i = \frac{k}{(k-1)} \left\{1 - \frac{\sum \sigma_b^2}{\sigma_t^2}\right\} \ldots (2)$$

$$r_i = \frac{20}{(20-1)} \left\{1 - \frac{9{,}45}{64{,}32}\right\}$$

$$r_i = 0.898$$

Based on the calculation results, the value of r is 0.898. If we look at the interpretation table for the r value (table-1), it is known that the reliability value of the instrument is included in the high category, so that the questionnaire instrument can be trusted when used for usage tests. The usage test was carried out at the Mathematics Department of FMIPA UNIMED. The instruments used cover six aspects, namely aspects of Additional Information, Affective Considerations, Interface, Navigation, Pedagogy and Robustness. A valid and reliable questionnaire instrument used for usage tests. The percentage of eligibility in terms of the Auxiliary Information aspect obtained an average value of 84.00%. Based on the aspect of Affective Consideration, the average data obtained is 85.57%. The interface aspect obtains an average data of 85.14%. Navigation aspect obtains an average data of 85.00%. The Pedagogical Aspect obtained an average data of 86.00%. The robustness aspect obtained an average data of 85.27%. Based on the results of these calculations, the average percentage of all aspects is 85.16%. Thus, it can be concluded that digital modules based on micro learning in sets and logic courses are categorized as very suitable for learning in the Mathematics Department of FMIPA UNIMED.

Conclusion

Based on the results of data analysis in this study, it can be concluded that digital modules based on micro learning in the set and logic courses can be categorized as very suitable for use in learning in the Mathematics Department of FMIPA UNIMED according to the assessment of media experts and material experts as well as students as users. The assessment score was 82.50% from media experts, 84.43% from material experts and 85.16% from users (students). The results of these calculations show that microlearning-based digital modules are feasible to use and are very suitable for learning in sets and logic courses in the Mathematics Department of FMIPA UNIMED.

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The effectiveness of microlearning to enhance research skills for pre-service mathematics teachers

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Abstract. *A meaningful learning experience is an important requirement for pre-service mathematics teachers in learning to do research. Learning activities in research methods require a system that demands knowledge regularly and keeps it remembered longer. However, the current learning system is snared in a conventional way of learning with a dense content of learning material. Microlearning learning innovation as a new paradigm provides a way of learning by dividing knowledge and information into small pieces to be easily understood and remembered longer. This study aims to examine the effectiveness of the microlearning teaching method for research courses in mathematics education students. This study selected two groups from Program Studi Pendidikan Matematika Universitas Negeri Medan. The microlearning method is taught in class 2018 A and the traditional method is taught in class 2018 B. This study describes how the contribution of learning using the microlearning method in supporting pre-service mathematics teachers' skills in conducting research.*

Keywords: Microlearning, research skills, learning method, mathematics education.

Introduction

The length of students' study in higher education is much influenced by the difficulties of students in research to support their writing of a thesis [1-3). Writing a thesis through research training is an obligation for undergraduate students in higher education [4]. Limited knowledge of research methods, the students' poor quality of communication with supervisors, lack of experience in academic writing, the supervisors' poor research method lesson plans, and too much material content research methods were identified as the main source of the difficulties [1, 5, 6]. Therefore, students' skills in conducting research and academic writing are considered to need special attention.

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The effectiveness of digital-based information technology innovation has a positive impact on undergraduate student learning outcomes in higher education [7-9]. The digital module is one of the many information technology innovations that can be offered to support research method courses [10, 11]. This innovation as a means of online and offline teaching materials for research method courses in mathematics education is both an opportunity and a big challenge for lecturers in higher education. The digital module is intended to strengthen the achievement of research method competencies, namely the ability to conduct research and academic writing. The integration of information technology for research methods courses in mathematics education with innovative approaches can be constructed and realized to support blended learning in higher education.

The application of digital modules in higher education presents new questions about what approaches are effective so that activities in research method courses can run sufficiently. The approaches need to pay attended to because the content of research teaching materials in mathematics education is too extensive. One approach that forms the basis for designing digital modules is microlearning. Microlearning is a new instructional paradigm that allows knowledge and information to be divided into small pieces so that they are easy to understand and remember for a longer time [12, 13].

The current problem in instruction is that undergraduate students are often trapped in traditional learning that does not motivate them to learn quickly and think creatively [14]. The modification in traditional instruction needs to be done by designing learning activities regularly to assist students to remember the teaching content longer [13]. [1] pointed out that the learning process at the higher level was not sufficiently supportive to develop students' abilities in scientific writing. Consequently, this study aims to evaluate the microlearning method in supporting pre-service mathematics teachers in research and academic writing skills.

Relevant study

Rapid and continuous development of technology influences every individual life and work environment. For this reason, fast learning is needed to improve the quality of everyone's life [13, 15]. Several studies reveal that traditional learning is unable to lead students to innovation and creativity because traditional cannot motivate students to learn new things [16, -18]. In addition, the knowledge students acquire from traditional learning is easily forgotten [19]. [20] revealed that the traditional learning process can reduce students' attention. The research results stated that the average student’s attention span decreased from 12 seconds to 8 seconds between 2000 and 2013.

Microlearning is a new instructional method that does not yet have a specific definition and is closely related to e-Learning. Microlearning arranges knowledge in undersized, comprehensible fractions. Today, almost everyone who uses the internet obtains the advantage of microlearning such as Googling, checking email, and reading and watching web content on the internet. Smart mobile devices allow us to take advantage of updated information sufficiently. This opportunity causes microlearning as a learning method for students to take advantage of access to updated information anytime and anywhere. In addition, the features available in information technology make the Microlearning method a learning speed that students can choose content for themselves. They can quickly access as much learned content as they want. The microlearning method can quickly equip students with the knowledge and skills they need according to the problems they want to solve [13]. One of the skills that can be supported by this method is research skills and academic writing.

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Academic writing skills can be interpreted as the skill of producing a paper based on standard regulations and using specific scientific methods [1, 21, 22. [23] expressed that several rules must be completed in writing scientific papers, such as the use of formal grammar, the selection of words, and the effectiveness of writing. [1] explained that to produce good scientific paper writing skills, special handling is required at each stage by controlling each stage through certain indicators. This study's goal is to construct microlearning supporting pre-service teachers in passing every stage of writing scientific papers. Activities designed in microlearning play a role in supporting the ability of prospective teacher students to conduct research and academic writing.

Methodology

This study aims to experiment with the effectiveness of microlearning methods in research courses for pre-service mathematics teachers. This study selected two groups from Program Studi Pendidikan Matematika Universitas Negeri Medan. The microlearning method had been experimented with in class 2018 A, while traditional instruction had been experimented with in 2018 B. Five research activities in developing academic writing skills applied to both traditional learning and microlearning are described in this study. This study implemented the research steps as shown in Figure 1 below. This study further compares the results of pre-service mathematics teachers' feedback.

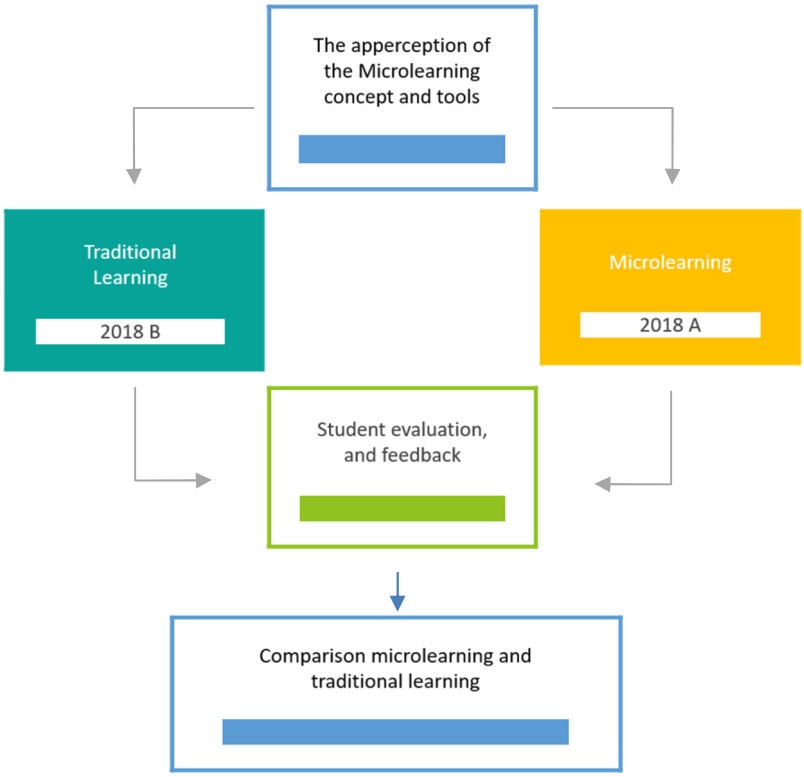


Figure 1. The process of research method

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Results and discussion

This study applied five research activities in stimulating academic writing skills in traditional learning and microlearning. Traditional learning is passive, which is generally a teacher-centered learning process. The microlearning method, which is different from traditional learning, makes students the center of the learning process. Students can use IT media as a package for microlearning.

Microlearning was utilized to present teaching materials on research method learning. The utilization of IT media in microlearning can transform concrete and representative experiences in delivering research method lectures. This microlearning method strives to overcome the problem of the magnitude of the content of teaching materials for research method courses and the lack of independent learning media for students.

A long textbook, which students need a relatively long time to read and understand, can be presented effectively in a short film. Therefore, making a film essay requires a synopsis to provide an overview of the theme of the content that you want to work on. Besides learning videos, this research utilizes audio applications for podcasts. Podcasts aim to record audio that can be shared with students' devices. Students can use mobile podcasts to listen to research method lecture materials. The podcast contains recorded audio files that can be sent to users via portable media devices such as computers, laptops, music players, and smartphones. The podcast used in this study is Spotify. This study evaluating students during the learning process is presented in table 1.

Table 1. Evaluation of traditional learning and microlearning passing rate

No.	Activities	Learning Method		Difference
		Traditional Learning	Microlearning	
1	Creating a mind map of research	32%	68%	36%
2	Analyzing relevant and related research	27%	68%	41%
3	Determining research problem	32%	64%	32%
4	Collecting and analyzing research data	32%	64%	32%
5	Writing results and discussion	27%	73%	45%
Passing average		25%	56%	31%
Difference average				31%

The microlearning method can accommodate student responses in learning research methods. This method has a complete system such as tutorials, references, simulations, and short and complete information. This microlearning method also facilitates students to learn independently. Evaluation of feedback in this study shows student learning motivation based on the microlearning device shown in table 2.

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Table 2. Students' feedback on microlearning instruments

Microlearning Instrument	Percentage
Interactive Infographics	90%
Motion Graphics	90%
Podcasts	92%
Explainer videos	93%

The survey shows the students' desire for microlearning tools. The table indicates that explainer videos and podcasts are students' preferred devices. While infographics and motion graphics take more minimum percentage than explainer videos and podcasts.

Conclusion

This study experimented with five research activities in microlearning and traditional learning classes to develop pre-service mathematics teachers' research and academic writing skills. The study shows that microlearning is effective in presenting teaching materials in learning. The microlearning method can grow pre-service mathematics teachers' research and academic writing skills by up to 31% compared to traditional methods. Based on research, microlearning can transform concrete and representative experiences in delivering research methods lectures for pre-service mathematics teachers.

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The development of digital module: project-based learning activities in regression and variance analysis courses

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Abstract. *Low experience in designing learning media affects the quality of the pre-service mathematics teacher in teaching mathematics. The main problem identified that the lack of knowledge about the characteristics, selection, design, mastery of use, and evaluation of instructional media planning. Therefore, this study aims to design a hypothetical learning trajectory (HLT) in learning media courses with a project-based learning approach to support pre-service teachers' abilities in developing effective learning media. The research method used is design research with three stages, namely preliminary design, teaching experiment, and retrospective analysis. The research subject is pre-service mathematics teachers of 2020 in Program Studi Pendidikan Matematika Universitas Negeri Medan. This study describes the contribution of the learning trajectory developed in developing students' skills in designing learning media.*

Keywords: learning media, hypothetical learning trajectory, project-based learning

Introduction

One of the pre-service mathematics teachers' problems in teaching is influenced by their difficulties in designing learning media [1, 2]. For students in schools, learning media has an essential role in increasing their motivation and understanding of learning mathematics. Training in designing and trying learning instruments conducted by undergraduate students on microteaching activities is needed to concern carefully. The minimal knowledge in mapping school students' characteristics, selecting and designing, mastering the use, and evaluating planning of learning media was identified as the source of problems faced by these undergraduate students [3]. In learning media courses, critical thinking needed to be developed in compiling learning media continuously because it supported undergraduate students' skills to improve their teaching skills [4]. Learning media design skills requires learning trajectories that contain learning activities. Therefore, this research offers a learning trajectory to support learning media courses.

Many investigations have been conducted on the role of hypothetical learning trajectories in several lecture materials [5,6]. The research examined that hypothetical learning trajectory has an essential role in learning [7-9]. Other research also showed that hypothetical learning trajectory

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affects preservice teachers' learning quality [10]. These studies also documented the success of learning trajectory designs in lectures. However, most have not touched on learning media courses and involve a project-based learning approach as a lecture approach.

Designing a hypothetical learning trajectory in lectures raises new questions about what proper approach to support learning media lecture activities running sufficiently. Synchronization between learning activities with the hypothesis needs attention. This study chose a project-based learning approach as its learning model. Project-based learning is a teaching paradigm that allows designing complex problem-solving activities through projects to produce a product [11].

The learning process's current problem is undergraduate students are trapped in traditional learning methods that unmotivate them to learn fast and solve problems [12]. Traditional learning needs to be modified by designing a learning trajectory to support undergraduate students' analyzing and problem-solving skills [13]. Consequently, based on the idea above, the quality of hypothetical learning trajectory development with a project-based learning strategy is crucial to be examined supporting undergraduate students' learning media design skills in mathematics education.

Methodology

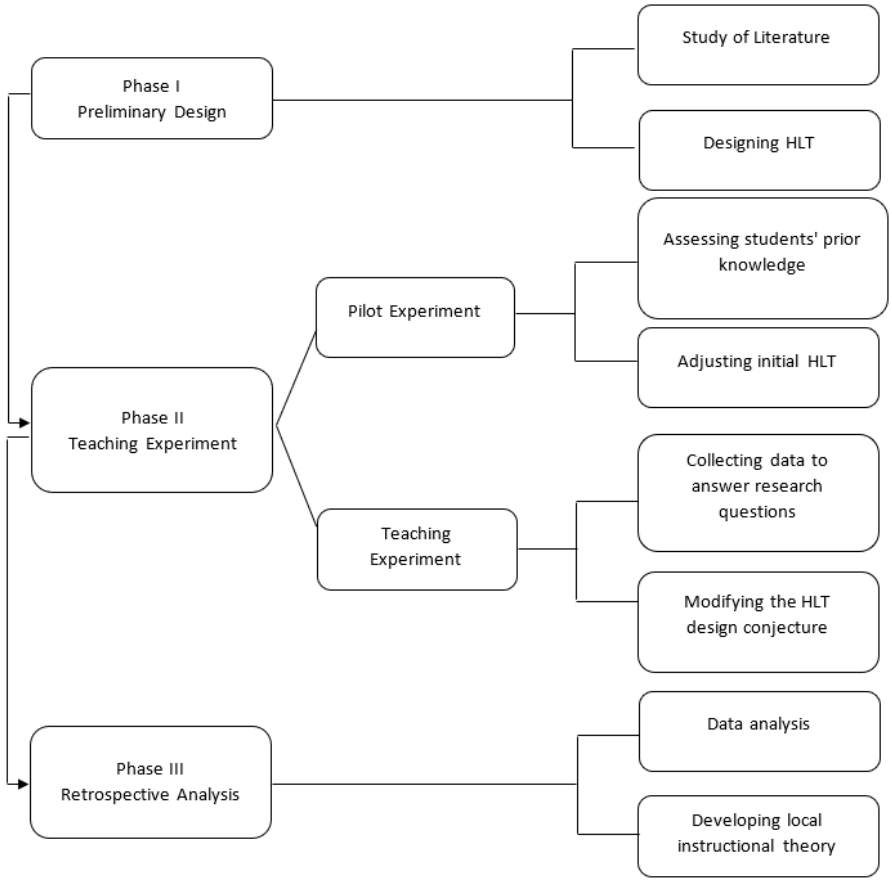


Figure 1. Phase activities of HLT development

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This study aims to design a hypothetical learning trajectory (HLT) of a learning media course with a project-based learning approach to support the learning media design skills in Program Studi Pendidikan Matematika. The method used in this study is the design research to answer the research problem and complete the research purpose. Design Research is a research method that aims to develop a local instructional theory or local instruction theory through collaboration between researchers and teachers to improve the quality of learning [13]. This study develops a hypothetical learning trajectory in the learning media course. Project-based learning is applied to control the learning process. Undergraduate students in Batch 2019 were involved as research subjects. The Research consists of a preliminary design, teaching experiment, and retrospective analysis. The aspects examined are presented in the diagram as shown in Figure 1.

Result and discussion

Phase i: preliminary design

At this stage, a front-end analysis has the goal analyze the material for learning media courses was developed. The literature about teaching materials and teaching methods was reviewed. It aims to adjust the conjecture of strategies and pre-service mathematics teachers' initial thinking about the learning media design. This step also identified why a hypothetical learning trajectory and a project-based learning approach are needed. The development of a hypothetical learning trajectory also heeded curriculum analysis, lesson plans, and students' initial abilities observations. pre-service mathematics teachers' initial abilities became the basis for the design of learning trajectories and hypothetical learning trajectories. The conjectures of the local instructional theory were formulated into learning objectives, learning activities, and learning tools to assist the learning process of learning media design. The learning trajectory developed in this study can improve pre-service mathematics teachers' learning media design skills. This research produces the learning trajectory of learning media presented in Figure 2.

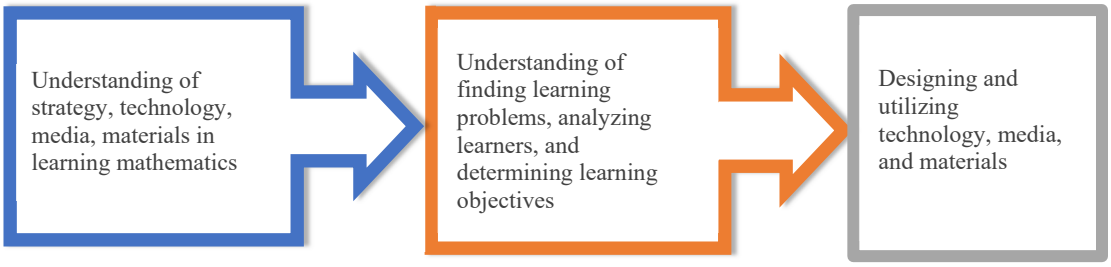


Figure 2. Learning trajectory of learning media

A set of instructional activities for designing learning media was developed based on the hypothetical learning trajectory and pre-service mathematics teachers' thinking processes. Instructional activities were divided into four activities completed in 16 meetings. Figure 3 shows the relationship between student learning trajectories and learning activities to enhance learning media design skills for pre-service mathematics teachers.

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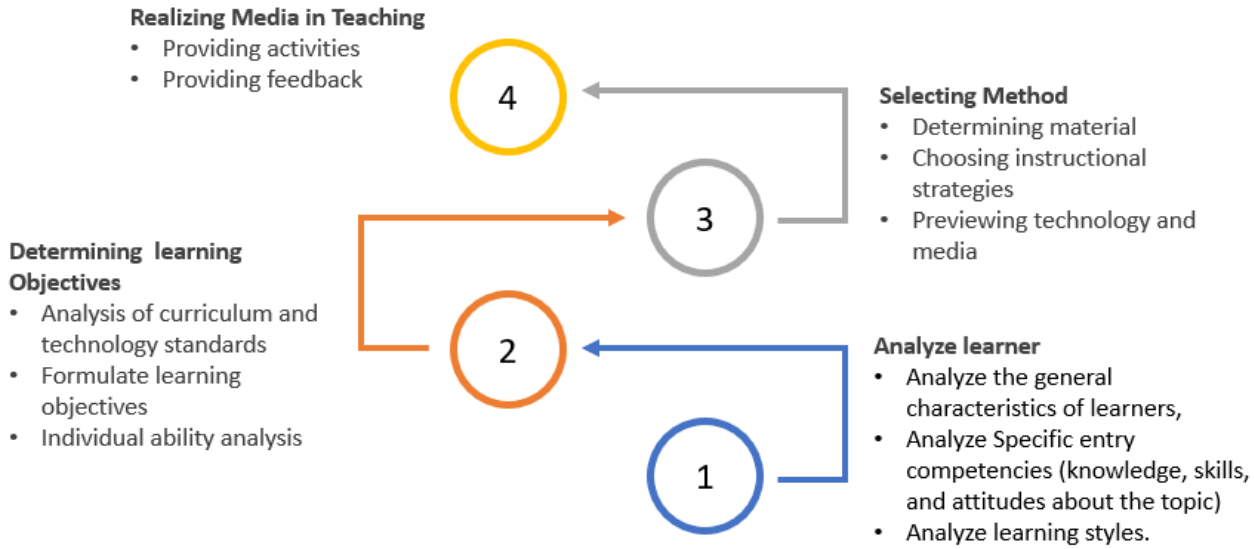


Figure 3. The hypothetical learning trajectory on learning media

Phase ii: teaching experiment

This second stage experimentalized the developed HLT. This experiment aimed to explore and hypothesize students' strategies and thoughts regarding learning media designing skills during the learning process. During the process, the conjecture can be modified as a revision of local instructional theory for the next activity. Furthermore, pre-service mathematics teachers design instructional media based on teaching materials and student characteristics analysis results. After that, they state the main types of learner criteria in the systematic learning plans. Next, students discuss and determine learning objectives that include behavior, conditions, and student level of mastery of learning topics. After pre-service mathematics teachers analyze students and set learning goals that contain knowledge and skill competencies, they choose the right learning strategies, technologies, and media to achieve learning goals. Furthermore, pre-service mathematics teachers prepared lesson plans, technology, media, teaching materials, students, and the learning environment (classroom) and realized designed learning media in the learning process. To see the accuracy of media implementation, pre-service mathematics teachers evaluate the suitability between learning objectives and student learning outcomes. Figure 4 shows the process of realizing media in learning.



Figure 4. Teaching experiment of HLT development

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Phase III: Retrospective Analysis

The retrospective analysis aims to develop local instructional theory. This phase compared HLT with actual learning. Analysis of this stage is:

1. Pre-service mathematics teachers were able to observe and identify students' prior knowledge. They were able to determine media needs that are developed based on student characteristics, competencies, competency achievement indicators, and learning objectives analysis. They were also able to analyze students' learning styles that are relevant to the developed learning media.
2. Pre-service mathematics teachers were able to state specific standards and learnings objectives. They started by analyzing curriculum and technology standards for student performance criteria. They analyzed students' characteristics to assess how extent new skills in using media had to be mastered by students. They also study the use of technology and media and assess the achievement of learning standards or objectives.
3. Pre-service mathematics teachers applied lesson plans to utilize technology, media, and teaching materials to support students achieve learning objectives. They are qualified to (1) preview technology, media, and teaching materials; and (2) prepare the learning environment (class) and students in the learning experience.

Conclusion

This study creates learning trajectories in learning media using a design research methodology to improve learning media design skills for pre-service mathematics teachers. Learning media design skills was conducted in four stages in the learning trajectory. Students learned to design learning media through developed learning trajectories to produce media. Furthermore, the learning trajectory of learning media has an important role in enhancing pre-service mathematics teachers' learning media design skills.

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Application of statistical method teaching materials assisted by the SPSS program through student-centered learning to improve understanding ability

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Abstract. *This study aims to develop contextual-based statistical methods for teaching materials through student-centered learning to improve understanding skills. The subjects of this study were undergraduate students in a mathematics education study program who were randomly selected. The research design employed was pre-experimental using the One Group Pretest Post-Test design to assess the impact of the student-centered learning model and the contextual-based statistical method teaching materials developed. The data collection techniques used were questionnaires, observations, and tests. Data was analyzed using descriptive, qualitative, and t-test analysis techniques. The research begins by defining and designing the curriculum, which includes, among others, teaching materials, learning objectives, formulating understanding abilities, and developing student-centered learning. Furthermore, a trial was conducted on teaching materials and learning models, and a test was carried out to determine the increase in evidence ability. The final stages of this research are research data analysis, discussion, conclusion, and research reporting. The results showed that the ability of understanding taught by student-centered learning by applying the teaching materials of the SPSS Program Assisted Statistics Method resulted in student learning activities as well as positive attitudes and better student motivation.*

Keywords: student-centered learning, statistics method teaching materials, and comprehension ability.

Introduction

The Statistical Method is one of the pre-requisite courses for the Research Methods course, which is incorporated in the Applied Mathematics group or cluster that is application. As a prerequisite course, understanding the concepts in this course will be very important for other applied courses, especially research methods courses [1]. The characteristics of this Statistical Methods course are courses that have applied concepts related to problems in real or contextual life. Therefore, an

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understanding of the concept of statistical methods is very important [2]. Students' understanding of a certain concept in statistical method material is always an obstacle in the advanced learning process, for example in research methodology courses. For example, in research methodology materials, there are concepts of validity and reliability that should have been understood by students, but in reality, when the material is used in research methodology courses, many students still do not understand these concepts. It can be seen how important the ability to understand concepts in the learning process is to the continued learning process [3]. Therefore, as a lecturer in statistical methods, this problem needs to be a serious concern. It is suspected that the learning that has been conventional so far is one-way learning without using IT programs, which are currently growing very rapidly[4]. The SPSS program that has been developed is an application program for statistics that is very helpful both in calculations and in understanding concepts. The researcher saw that the learning process of the statistical method without using the SPSS program made the learning process less interesting.

Saragih (2015) Judging from the ability of students, conceptual errors such as the case above are very likely due to, among others: (1) the lack of prerequisite knowledge that students have; (2) the attitude of students who lack interest or motivation in studying the material; (3) often students are just silent and afraid to ask questions, do not dare to express ideas; (4) the learning process is monotonous using textbooks; (5) the presentation of material that does not consider the level of cognitive abilities and the context of the real world of students results in less than optimal student interaction; and (6) evaluation that only refers to the results and not the process [5-7].

Meanwhile, to maximize learning interactions between fellow students, it is carried out through a student-centered approach. The evidence from the post-Saragih research grants conducted in 2015 and 2016 supports the notion that a student-centered method of learning can improve the mathematical thinking skills of junior high school students at a high level [7-8]. Likewise, the results of research by Syafari and Saragih (2014, 2015) show that the ability of proof for the tertiary level is still very low, and it is further reported that the ability of proof can be improved through cooperative learning assisted by concept map media [9].

Methodology

The study employed a pre-experiment method with a One Group Pretest-Post Test research design. Sugiyono (2010) explains that in the research design, prior to the action, a test (pretest) is carried out, and at the end of the learning, a posttest (final test) is given. This design is used in accordance with the intended purpose, which is to determine the improvement resulting from the treatment. The following table describes the research design: one group pretest-posttest [10].

Table 1. Research Design

PreTest	Treatment	Posttest
O_1	X	O_2

The flow and stages of the research begin with the preparation stage, namely, literature study, analysis of curriculum and material for statistical methods, sample selection, and learning design and understanding ability instruments. Furthermore, the implementation phase begins with a pretest (O1), continues with the implementation of learning, and ends with a posttest. The final stage is to process data, analyze research data, discuss, conclude, and prepare reports. The following is a Figure 1. [11] of the flow and stages of the research.

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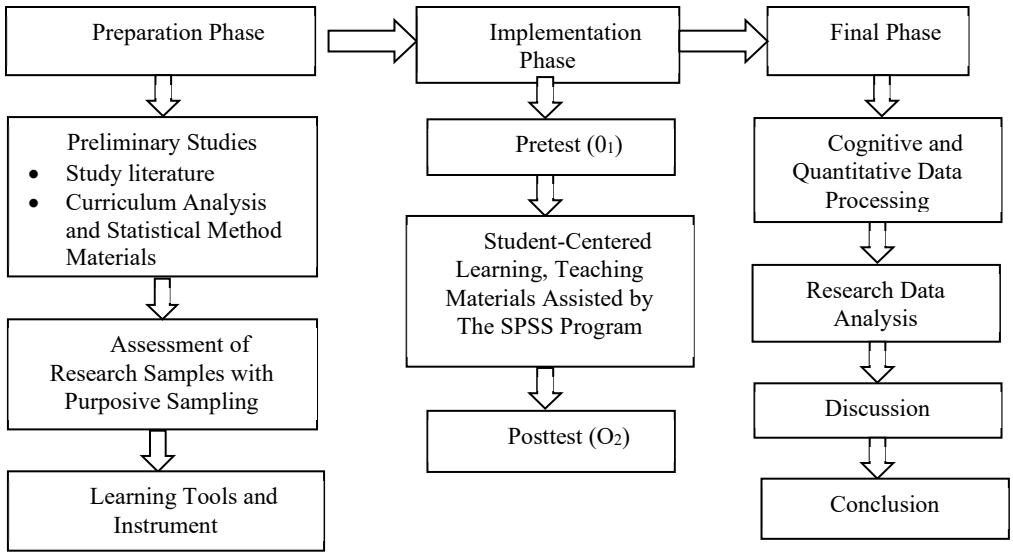


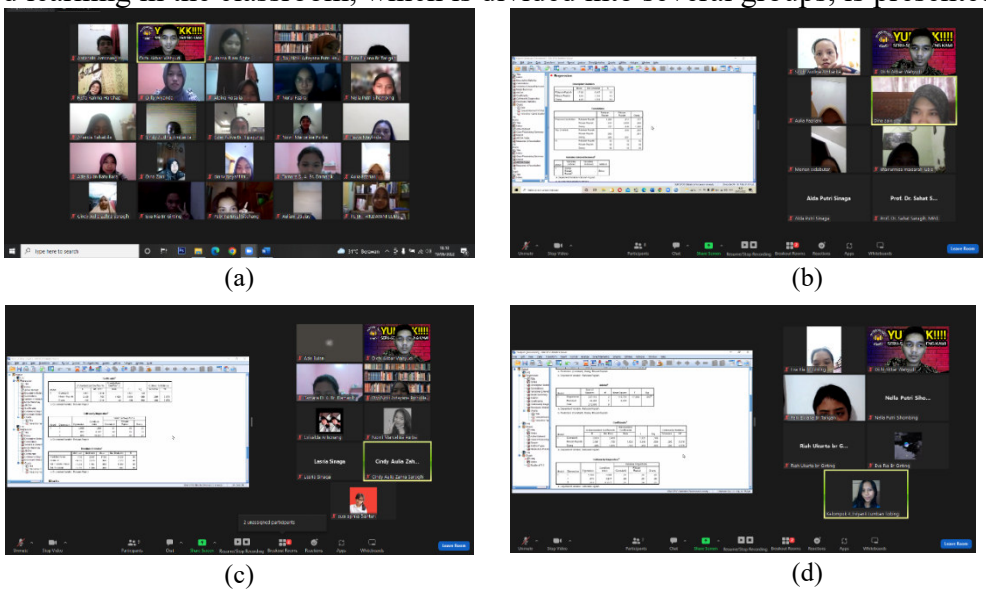
Figure 1. Research flow and stages

Result and discussion

The results of this study were in the form of a test class totaling 45 students. The research was conducted over 4 meetings, which were divided into 6 study groups to see the students' understanding of centralized learning. Besides that, from the results of the comprehension ability test, quite good results were obtained, and the positive attitude shown by the students made the learning process of statistical methods assisted by the SPSS program better. The results achieved from this study are presented as follows.

1. The learning process in the class

The learning process is centered in the classroom during the research carried out in groups, which is carried out online by creating study rooms for each group in Zoom Meetings. The picture of centered learning in the classroom, which is divided into several groups, is presented below.



(a) (b)

(c) (d)

Figure 2. Centered learning in the classroom

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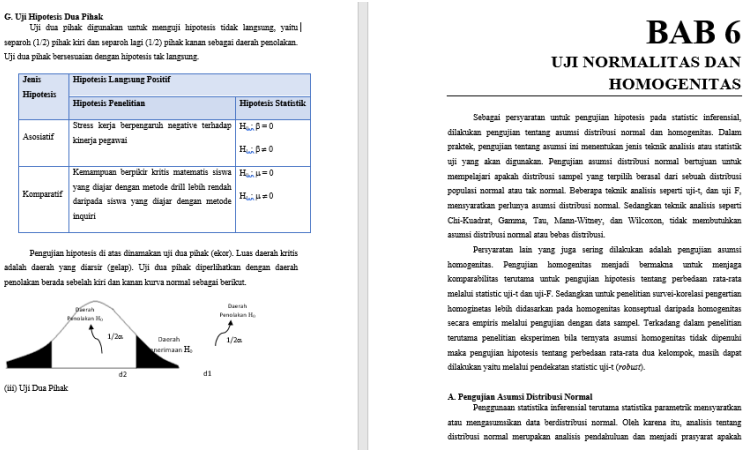


Figure 3. Display sub chapter material

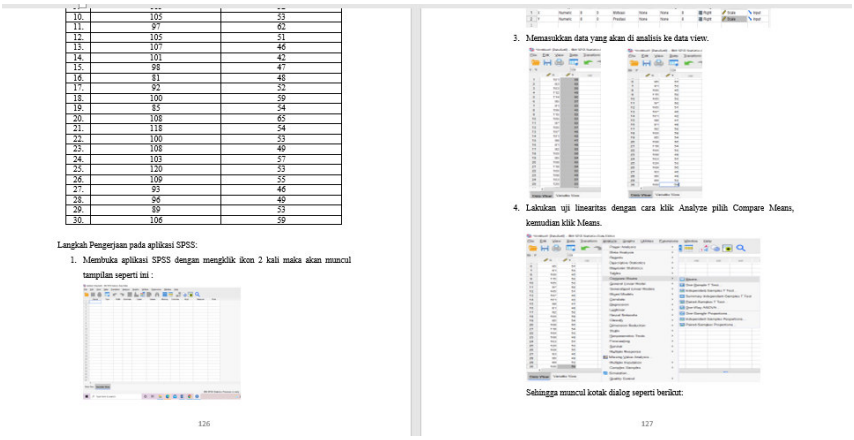


Figure 4. SPSS program usage book content display

2. Pretest and posttest results data

The analysis of the pretest and posttest results was conducted to measure the students' abilities before and after the learning process, or in other words, to measure their initial and final abilities in the taught subject matter. Descriptive statistical analysis of the pretest and posttest scores was conducted using the SPSS 22.0 program.

Table 2. Descriptive statistics of pretest and posttest data

Score	N	Mean	Minimum	Maximum
Pretest	45	61.00	47	78
Posttest	45	76.16	56	90

The presented table data shows that the average pretest score is 61.00, ranging from a minimum score of 47 to a maximum score of 78. Similarly, the average posttest score is 76.16 with a range of scores from 56 to 90.

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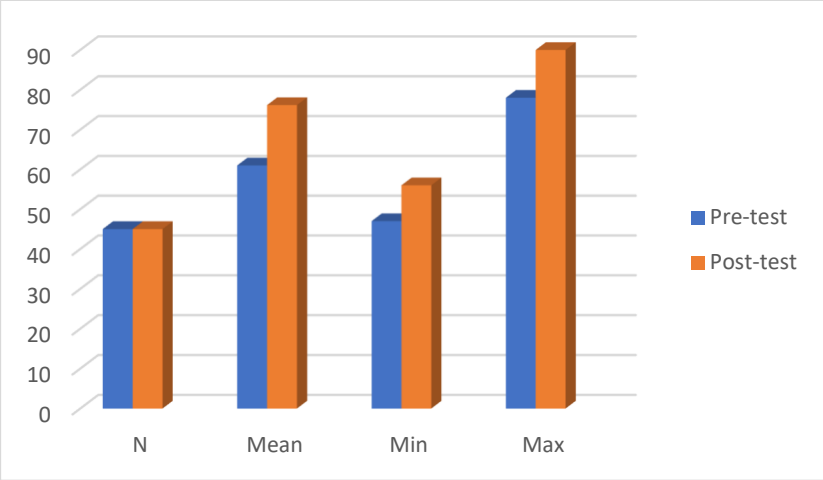


Figure 5. The average value of pretest and posttest

With the given data description and considering the graph, it can be observed that there is a significant difference between the average pretest and posttest scores. However, to determine if the difference is statistically significant, a statistical test will be performed.

2.1 Test for normality of pretest and posttest data.

A normality test was conducted to determine whether the data for both pretest and posttest are normally distributed or not. The normality test was performed using the Kolmogorov-Smirnov test statistic with the help of SPSS 22.0. The test results for both pretest and posttest are presented in the table below.

Table 3. Pretest and posttest data normality test results

Score	Z	Sig. (P)	∝	Conclusion
Pretest	.129	.059	.05	Normal
Posttest	.110	.200		Normal

Test criteria:

If (P) value > α (0.05), then normally distributed.

If (P) value < α (0.05), then it is not normally distributed

Based on the results of the normality test, the pretest had a P value of 0.059 and the posttest had a P value of 0.200. When comparing these values to α = 0.05, it was found that the pretest (P = 0.059) was greater than α (0.05) and the posttest (P = 0.200) was also greater than α (0.05). Thus, it can be concluded that both data sets are normally distributed.

2.2 Homogeneity test of pretest and posttest data

The purpose of the homogeneity test was to determine if the variances of the pretest and posttest data were equal. SPSS 22.0 was used to conduct the homogeneity test, and the results are shown in the following table.

Table 4. Results of homogeneity test of pretest and posttest data

	Levene Statistic	Df_1	Df_2	Sig.
Value	3.428	1	88	.067

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Test criteria:
If (P) value > α (0.05), then homogeneous
If (P) value < α (0.05), then it is not homogeneous.

As shown in the table above, the P values for the pretest and posttest were found to be P = 0.067. Upon comparison with α = 0.05, it can be concluded that since P = 0.067 is greater than α (0.05), the data is from a population with homogeneous variance.

2.3 Pretest and posttest difference test (hypothesis test)

Based on the results of the normality and homogeneity tests, it was found that the distribution of the pretest and posttest scores is normal. Therefore, to test the difference between the means of the two tests, a parametric statistical test, paired samples t-test, with a significance level of 5%, was used using SPSS 22.0.

2.4 The formulation of the hypothesis to be tested.

H_o : There is no significant difference between the average pretest and posttest scores, which means that there is no effect of a centered learning approach on students by applying the teaching materials of the Statistical Method Assisted by the SPSS Program in improving their understanding ability.

H_a : There is significant difference between the average pretest and posttest scores, which means that there is no effect of a centered learning approach on students by applying the teaching materials of the Statistical Method Assisted by the SPSS Program in improving their understanding ability.

2.5 Statistical hypothesis

$H_o : \mu_1 = \mu_2$

$H_a : \mu_1 > \mu_2$

2.6 One party hypothesis test criterion

Independent Sample T-Test:

1. If $t_{count} > t_{table}$, then H_o is rejected, H_a is accepted.
2. If $t_{count} < t_{table}$, then H_o is accepted, H_a is rejected.

By Significance:

1. If (P) value > α (0.05), then H_o is accepted, H_a is rejected.
2. If (P) value < α (0.05), then H_o is rejected, H_a is accepted.

Table 5. Pretest and posttest t test results

Score	Df	Sig.(P)	∝	t_{count}	t_{tabel}
Pretest	44	.000	.05	-12.058	2.01537
Posttest					

According to the table above, the significance (P) is 0.000. This is because the P-value (0.000) < α (0.05) and the calculated t-value (12.058) > t-table value (2.01537). As a result, the null hypothesis (H_o) is rejected, and the alternative hypothesis (H_a) is accepted. In other words, it can be concluded that there is a difference in the average between the pretest and posttest scores, indicating that the use of teaching materials for the SPSS-assisted statistical method has a positive impact on the students' comprehension abilities.

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3. Results of N-Gain Data Analysis

The difference between the posttest and pretest scores is used to calculate the gain score. The learning outcomes refer to what students have achieved after the learning process, in this case an improvement. To determine the difference in the average results between pretest and posttest scores, which indicates the impact of student-centered learning by applying teaching materials on the SPSS Program Assisted Statistics Method in improving students' ability to comprehend, a normalized gain calculation is used. The results of the <g> normalization gain calculation for the pretest and posttest learning outcomes are displayed in the table below.

Table 6. Results of the n-gain index of pretest and posttest learning outcomes

	Pretest	**Posttest**	**Gain**	**<g>**	**Category**
Value	61.00	76.16	15.16	.38	Moderate

According to the pretest and posttest data, the normalization gain score is 0.38. This value falls within the criteria of $0.3 \leq g \leq 0.7$, which classifies the student-centered learning achieved using the SPSS-assisted statistical method teaching materials as moderate in terms of enhancing comprehension ability.

Conclusion

Based on the results of the study, the conclusions from this research are the average results of the ability to understand centralized learning obtained are t_{count} (12.058) > t_{table} (2.01537), There is an effect of student-centered learning by applying teaching materials for the SPSS Program Assisted Statistics Method in improving students' abilities. Understanding. Student-centered learning by applying teaching materials of the Assisted Statistics Method SPSS program can produce student learning activities, as well as positive attitudes and better student motivation.

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Teachers' conceptions on the use of technology to develop students' creative thinking in mathematics: evidence from moderated forum group discussions

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Abstract. *While promoting mathematical creativity is one of the aims of mathematics education, research on investigating teachers' views of integrating technology into teaching which promotes creative thinking is rarely studied. This study investigates mathematics teachers' conceptions about technology use in supporting students' creative thinking in mathematics. We analyze the aspects of such conceptions related to the concepts and the assessment of creative thinking, the technology used in mathematics learning and how it can support students' creative thinking in mathematics instruction, and pedagogical skills to promote creative thinking. Data were collected through recorded video observations and field notes of three moderated forum group discussions (M-FGDs), each involving ten mathematics teachers from three districts in East Java Province. Our qualitative interpretations of the M-FGDs depict that teachers tend to define creative thinking as thinking skills associated with divergent thinking although few of them relate it with irrelevant concepts such as critical thinking and conceptual understanding, which leads them to fail in proposing a scheme of assessing students' creative thinking. Also, they are of the varied view that technology should be inserted to replace traditional tools, which do not change learning methods that are relevant to creativity and none of them connects the idea of integration with transformation scenarios. Some pedagogical skills related to teacher needs of mastering the technology and knowledge of creating and selecting technology-assisted tasks were suggested to support students' creative thinking.*

Keywords: creative thinking, technology in mathematics learning, in-service teacher

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Introduction

In recent years, research on the investigation of creative thinking as an essential skill in the curriculum of school mathematics, either for theoretical or practical development in mathematics education, has been expanding not only in the aspects of cognitive [1,2] and affective performances such as belief system (conceptions, view, perspective, perception) of students [3], but also those of teachers [5-7]. For example, according to recent empirical research, studies on teachers' beliefs about the promotion of creativity, the strategies that support creative pedagogy (both teaching for creativity and creative thinking in classroom instruction), and teachers' perceptions of the factors that either support or hinder creativity in the classroom are all included [5]. In addition, teachers' role in developing students' creative thinking is becoming increasingly demanding since research shows that there is a positive correlation between teachers' conceptions and performances on creative thinking and students' creative thinking in mathematics [8]. Furthermore, research literature also highlights the interconnectedness of teachers' conceptions and their practice: teachers' pedagogical and mathematical beliefs affect the level of their mathematics classes, while the teaching process itself shapes those conceptions [9,10].

While large collections of studies support such mentioned findings, research on developing students' creative thinking in mathematics has also been emerging in terms of the use of technology [11,12]. Concerning teachers' use of technology in fostering students' creative thinking, [13] indicate that even expert teachers have difficulty implementing learning that integrates technology that fundamentally changes learning methods to develop the creative thinking of their students. Despite there is emergent research on the relationship between creativity and technology in the field of education, past literature reviews and meta-analyses indicate that very few studies have looked at how technology-enhanced learning interventions affect students' creativity [14]. While past research concerned on teachers' views of creative thinking and creativity [15-19], teachers' view on the integration of technology in teaching practice is scant, especially in teaching mathematics supporting students' mathematical creative thinking [20].

In studying teachers' knowledge and beliefs about integrating technology-supported teaching for creative thinking, scholars have proposed pieces of the analytical framework as tools of investigation. Teachers' conceptions, which are perceived as a construct integrating the teachers' knowledge and beliefs [9], has become one of the central issues in teacher education for several scholars. Through their significant work with teachers, Niess, Sadri, and Lee [21] and Niess et al. [22], for example, developed a five-stage method that they employ when learning to include technology in the teaching and learning of mathematics, namely recognizing, accepting, adapting, exploring, and advancing, in which such steps indicate a hierarchical level of integration. Another framework of RAT (replacement, amplification, and transformation) was proposed by Hughes et al [23] and attracted many researchers from multidiscipline to examine teachers' level use of technology integration [24,13].

In this framework, replacement indicates that technology is only used at the beginning (e.g., motivation, introduction), then in the process of teaching, a teacher using such a technology abandons, and returns to usual learning practices. In other words, technology is only used to replace tools for counting, drawing, checking the correctness of calculations, or sketching the graph. Amplification, on the other hand, is indicated as the use of technology in the learning process to increase efficiency and productivity but does not change the original learning flow.

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The highest level, transformation, can be seen in the use of technology which completely promotes new learning settings effectively (teaching), student learning processes (learning), or new curricular goals (learning objectives).

Some important findings related to the teachers' conceptions of creative thinking and creativity in mathematics and the use of technology supporting students' creative thinking employing the RAT method were reported. For example, according to an analysis by Bolden et al [15], pre-service teachers' notions of creativity were limited, mostly connected to the use of tools and technology, and linked to the idea of "teaching creatively" rather than "teaching for creativity." They added that preservice teachers' concepts become less restricted as they prepared to enter the classroom as recently qualified teachers, but they were still unable to pinpoint strategies for fostering and evaluating creativity in the classroom. By this finding, scholars such as Lev-Zamir and Leikin [25] agree that to develop teachers' capability of teaching with and for creativity, they should better understand their conceptions of creativity in mathematics. Additionally, the analysis of Bereczki and Kárpáti [13] showed that the use of technology by expert teachers to stimulate creativity was influenced by their epistemic ideas about it. Thus, the aim of this study is to examine teachers' views of creative thinking and how technology should be employed in their pedagogical practices which support students' creative thinking..

Methodology

This study used a descriptive-explorative design to explore teachers' conceptions of creative thinking in mathematics and how it is integrated with technology to support students' development of creative thinking. The teachers' conceptions of such focuses were analyzed using qualitative content analysis of teachers' repeated observations of the videotapes and repeated readings of the transcripts drawn from three moderated group discussions (M-FGD) held online via an online meeting platform.

The moderation process is clearly stated in the forum through a comprehensive set of guidelines by optimizing the role of the moderator, who is the researcher, to convey the purpose of the discussion and maintain the rhythm of the discussion so that all aspects that are planned to be discussed can be revealed in as much detail as possible from the teacher participants. In this regard, the moderators played a key role in the discussion by fostering pleasant and comfortable surroundings for the participants as well as managing existing aspects of creative thinking, including how it relates to mathematics teaching with technology revealed by the participants during the M-FGDs.

The M-FGDs were held by involving three groups of mathematics teachers with various backgrounds in terms of years of teaching experience, sexes, and structural positions in the mathematics teacher community in each of three districts in East Java Province, Indonesia: Gresik (M-FGD 1), Mojokerto (M-FGD 2), and Sidoarjo (M-FGD 3). Each of the M-FGDs was held separately, each of which lasted for about three hours through online meetings. The qualitative content analysis followed the analytical scheme of directed content analysis [9] which led to a search for patterns that indicate aspects of the teachers' conceptions.

For each focus group discussion session, a list of questions was created as guidelines for the moderators to organize the work of the M-FGDs. The list of questions was derived into five main focuses: technology use in mathematics learning, integration of technology in mathematics learning, creative thinking in mathematics, technology-integrated learning supporting students'

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creative thinking, and pedagogical skills to support technology-integrated learning which encourages students' creative thinking. A detailed list of questions is given in Table 1.

Table 1. Focused topics of the M-FGDs

Focused topics of discussion	Questions
Technology use in mathematics learning	What is meant by technology in learning? What is the role and function of technology in learning? What types of technology are often (or have been) used in learning mathematics? How do teachers use technology? Are there any difficulties? How to solve it?
Integration of technology in mathematics learning	Why is it necessary to integrate technology into mathematics learning? What are examples of integrating technology in learning mathematics?
Creative thinking in mathematics	What is meant by creative thinking? How to assess creative thinking? What are the learning strategies to develop creative thinking skills?
Technology-integrated learning supporting students' creative thinking	What is the role of technology to improve creative thinking skills? How to integrate technology in mathematics learning to improve creative thinking skills?
Pedagogical skills to support technology-integrated learning supporting students' creative thinking	What knowledge is needed in using technology to improve creative thinking skills? What are certain stages or mechanisms for teaching mathematics to improve students' creative thinking skills?

The questions listed in Table 1 were adapted from previous research which specifically examined teachers' conceptions of creative thinking in mathematics [15,25,9] and the use of technology in mathematics learning. Meanwhile, the last two focused topics of discussion were proposed to examine teachers' conceptions of integrating technology to improve students' creative thinking.

To analyze the data, we processed the data coding by involving two steps. The first phase is initial coding, which is creating a large number of category codes without putting a cap on them [26]. At this point, we found terms used frequently by respondents as markers of significant themes and to summarize new ideas. Then, we reduced the coding categories discovered in the first stage through focused coding, which takes place in the second stage. It is important to pay attention to reoccurring patterns and larger ideas that connect the codes [26]. As a supplementary, we also compared the codings from the observed video with the field note we resulted during observing the discussion occurred.

Results and discussion

Teachers' conceptions of technology use in mathematics learning

Table 2 summarizes the responses of the participants from three M-FGDs regarding conceptions of technology in mathematics learning concerning three sub-aspects, namely the meaning of technology in mathematics learning, role and function of technology in mathematics

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learning, and types of frequent use of technology in mathematics learning. It is highlighted that the teacher participants from the three districts tend to agree that technology is both digital and non-digital tool that enables teachers to teach mathematics easily. Regarding the roles of technology, they revealed that three big issues are concerned, namely tools for delivering a lesson, assessing students' learning, and evaluating the correctness of students' responses.

Table 2. Teachers' observed responses on technology use in mathematics learning

No	Questions	M-FGD 1	M-FGD 2	M-FGD 3	Conclusions
1	What is meant by technology in learning?	Technology is a tool or means/media that makes it easier for someone to do work (read learning), such as LCDs, laptops, etc.	Technology in learning is a digital learning tool used by teachers in teaching such as mobile phones, Google Classroom, Learning Videos, Calculators, etc.	Technology is anything that helps humans to facilitate human work	Technology in learning is everything (tools or media) both digital and non-digital that makes it easier for a teacher to teach. Example: Mobile, Laptop, LCD, Google Classroom, Learning Videos, Calculator, etc
2	What is the role and function of technology in learning?	As a tool in learning, for example as a learning media	Make it easier for students to understand the concepts being studied.	Facilitate the teacher in delivering the material	The role of technology in learning is to assist teachers in (1) delivering material (technology as a learning medium) (2) evaluate learning (3) justifying the correctness of students' answers The function of technology in learning: (1) make it easier for teachers to deliver the material (2) make it easier for students to learn the material
3	What types of technology are often (or have been) used in learning mathematics?	Codamath visualization (Scales) of linear equations of one variable	As an assessment tool	Make it easier for students to learn the material	Technological applications used by teachers (1) in conveying the material. Examples: Codamath, office insert statistics data, geogebra, and learning videos (2) in the assessment. Example: Quiziz, Brainly

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					(3) in designing worksheets or presentation media. Example: Canva (4) in solving problems. Example: Photomath (5) assign tasks and collections. Example GC

. However, the idea of additional chances for students to see and engage with mathematical ideas made possible by technology was not found properly in the teachers' responses although M-FGD 2 could specifically be mentioned that technology can be used to facilitate students' understanding of mathematical concepts. This finding is found when one of the participants of M-FG 2 said, "Utilizing games, simulations, and the technological tool could encourage students to explore and discover new things." Table 2 summarizes the responses of the participants from three M-FGDs regarding conceptions of technology in mathematics learning concerning three sub-aspects, namely the meaning of technology in mathematics learning, role and function of technology in mathematics learning, and types of frequent use of technology in mathematics learning.

Integration of technology in mathematics learning

Table 3. Teachers' observed responses on the integration of technology in mathematics learning

No	Questions	M-FGD 1	M-FGD 2	M-FGD 3	Conclusions
4	What is an example of integrating technology in learning mathematics? and how it is used in mathematics teaching practice?	The use of GeoGebra to check the correctness of students' answers. The use of GeoGebra (which is already available on the internet) to explore material, for example, plane figure	Use of GeoGebra to check student answers manually The use of Animated video is used at the beginning of learning or replaces part of the teacher's explanation (not always a substitute). Youtube videos to complement and strengthen the teacher's explanation.	The use of GeoGebra to check the answers to graph sketches made by students. Using excel is used to find the area of a flat shape, the volume of a sphere with the formula that has been made	Integration of technology in learning mathematics that has been done by the teacher is Use software (GeoGebra and excel) to check the truth of students' answers Using animated videos to motivate the beginning of learning Use learning videos to change the teacher's role in explaining the material or to complete or strengthen the teacher's explanation

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Table 3 indicates teacher participants' responses on how to integrate technology into mathematics learning. While the participants tend to exemplify kinds of technology that can foster students' mathematics experiences such as using GeoGebra, online videos, or excel (spreadsheet) to model some specific mathematical explanations, no response was found to indicate the integration of mathematics content knowledge, pedagogical content knowledge, and knowledge of technology use considering specific pedagogical content knowledge, known as Technological Pedagogical Content Knowledge (TPACK). In this regard, teachers should consider the students' technology knowledge needs, the mathematics subject knowledge they will need, and the best methods for teaching both technology and mathematics when planning to include technology into a lesson. Without it, the technology might be included in a way that is pedagogically improper for teaching mathematics, hence this step is crucial.

Creative thinking in mathematics

Table 4. Teachers' observed responses on creative thinking in mathematics

No	Questions	M-FGD 1	M-FGD 2	M-FGD 3	Conclusions
5	What is meant by creative thinking?	Creative thinking is thinking broader or more than usual. Creative thinking can be said that students can make their own formulas. Creative thinking also thinks in its own way, thinking in an unusual way (in a simpler way without being taught by the teacher). Creative thinking means thinking of finding new ideas to solve problems, Creative thinking is not the same as creativity, because creativity is an activity (producing a product), a product	Creative thinking is the effort of the mind, an activity that is reasoned by intelligence to achieve goals. Creative thinking means that students can use concepts in solving problems, apply concepts in solving everyday problems, link between concepts to solve a problem. Creative thinking is thinking differently. (Students' complete with procedures different from what is learned).	Creative thinking is thinking in solving problems not only in one way. Creative thinking means thinking out of the ordinary. In mathematics, solving problems in their own way, whether they have been taught or not. Creativity is the result or product of being creative, while creativity is the process. Creative thinking means being able to maximize certain gadgets or applications in solving problems.	Some of the teacher's understanding regarding creative students, creative thinking, and creativity Students are said to be creative if (1) able to solve problems in their own way (different from what was learned) (2) able to use concepts in problem solving activities (3) able to solve problems using more than one way (4) being able to use certain gadgets or applications to solve problems Creative thinking is non-routine thinking to find new ideas to solve problems Creative thinking is more about the process, while

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			Creative means not only thinking routinely but being able to think of more than one way to solve a problem Creative thinking is a process; creativity is a product.		creativity refers to the product
6	How to assess creative thinking?	Create a rubric for more than one answer because the proposed assignment is open-ended. If the value is incorrect and does not comply with the procedure, it will be given a low score. The correct value and according to the procedure are given a higher value. Values correct and not according to general procedures are given a higher score	Finding from the unknown to knowing so that many solutions were found. Judging it is being able to explain well with other friends	Never designed explicitly to judge students' creative thinking	Teachers' understanding related to how to assess creative thinking is still minimal because they have never intentionally designed questions that are intended to collect these skills.
7	What is the teaching strategy to develop creative thinking skills?	Using open-ended questions	Using PBL or PjBL Assign Project tasks	Not yet designing learning that is specifically intended to develop creative thinking skills.	Some learning strategies used by teachers to develop creative thinking skills are (1) Using PBL or PJBL (2) Using Open-Ended Problems (3) Provide project assignments

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Table 4 points out three main focuses of exploring teachers' conceptions of creative thinking in mathematics, namely the nature of creative thinking in mathematics, assessment of creative thinking, and teaching strategies to support students' creative thinking. It was found that the M-FGDS reveal that the teacher participants tend to agree that creative thinking is more about the process, whereas creativity refers to the product. While this is agreed by the majority of participants from all the M-FGDs, they seem not to have an agreement on what it meant by creative thinking, what to assess, and how to assess student's performance regarding their creative thinking. This is indicated by the findings that many of them express their view of creative thinking, instead of mentioning keywords that represent what creative thinking is, such as the ideas of divergent thinking, they mentioned some irrelevant keywords which lead to other thinking skills in mathematics, such as critical thinking and conceptual understanding. For example, a participant of M-FGD 1 said, "Creative thinking is perceived as thinking of how to solve problems with the correct concept, and apply the concepts in solving everyday problems, hence, it is about linking between concepts to solve a problem".

Technology-integrated learning supporting students' creative thinking

Table 5. Teachers' observed responses on technology-integrated learning supporting students' creative **thinking**

No	Questions	M-FGD 1	M-FGD 2	M-FGD 3	Conclusions
8	What is the role of technology to improve the ability to think creatively?	Beginning with simple tasks that require different answers, followed by using technology to develop students' creativity		Concept exploration using excel or excel spreadsheet to represent data in the form of diagrams	Not clearly illustrated by teachers' understanding of the role of technology to improve the ability of creative thinking. A little picture is to use Excel or Spreadsheet to explore concepts and present data
	How to integrate technology in learning mat to improve the ability to think creatively?	By using worksheets and GeoGebra to exploit the nature of flat shapes. Quizzes for an assessment where students are competing to be better than their friends because there is a direct ranking	Drawing quadratic equations using excel	Using technology to assign tasks, collect assignments, solve problems	Technology integration in learning aimed at improving creative thinking skills (1) Use of GeoGebra for concept exploration (2) Draw charts using excel (3) Using Quizzes for assessment

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Table 5 shows the teacher participants' responses on how to integrate technology into mathematics learning which specifically promotes students' creative thinking in mathematics. There are main focuses discussed, namely the role of technology and how it is integrated into creative-thinking-supported instruction assisted by technology. It is clear that the ideas from teachers in these two focuses are not clear yet, meaning that the way they integrate technology only replaces and, in no way changes established instructional practices, student learning processes, or even content goals.

Pedagogical skills to support technology-integrated learning supporting students' creative thinking

Table 6. Teachers' observed responses on pedagogical skills to support technology-integrated learning supporting students' creative thinking

No	Questions	M-FGD 1	M-FGD 2	M-FGD 3	Conclusions
9	What knowledge is needed in using technology to improve creative thinking skills?	Need to understand the technology to be used Need to know the characteristics of students Strategies or ways to integrate technology in learning	Mastery related to the use of technology itself	The teacher must understand the use of the technology first.	The knowledge needed to integrate technology in learning that aims to develop creative thinking skills (1) Understand the technology to be used (2) Knowing the characteristics of students (3) Understanding strategies or ways to integrate technology in learning
10	Are there any certain stages or mechanisms to teach material to improve the ability to think creatively?	The stages are direct demonstrations to students, then students are asked to follow	Placed in front to explore students' answers	Be creative first, answer as best you can, then concept	Teaching flow to improve creative thinking skills (1) Asking students to respond to questions as best they can, just be taught concepts or (2) Demonstrating knowledge or skills to students, then students are asked to follow
11	Are teachers sure they can use technology? Are there no difficulties? How to solve it?	There is a concern that technology does not make it more effective but vice versa. Able as long as there is	Not convinced that technology can develop creative thinking in mathematics Sure, explore student creativity through technology	Understand the concept first and then lead to creative thinking gradually. The trick is to plant concepts until students	Teacher confidence in the use of technology in learning: Not sure because there is a concern that technology does not make learning

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		provision.	because students need it. Agree, but aware of the weakness of knowledge about the use of technology, should not turn a blind eye to the importance of mastering technology	understand, then use technology.	more effective. There is also a view that technology should be given after the concept is well embedded. Convinced, because students really need it for exploration activities. There are also those who believe but are aware of weaknesses in using it

Based on the results of the FGD several conclusions can be drawn as follows. Teachers' knowledge of technology (TK), knowledge of technological content (TCK), technological pedagogical knowledge (TPK) and knowledge of technological pedagogical content (TPACK) are still minimal. As evidence, it was revealed that several factors, one of the factors causing not many teachers to integrate technology in learning were the low mastery of teachers on technology (TK and TCK were minimal), the ability to integrate technology in learning and knowledge about the characteristics of students in learning.

In the aspect of integrating technology in learning, most of teachers are still at the lowest stage, the replacement or augmentation stage. In the replacement phase, technology is used to replace the traditional approach to teaching (with no visible differences in student activity) [23]. One indication of this is that teachers often use power points as a tool to explain material or use learning videos (eg YouTube) to replace their position in explaining. At the augmentation stage, although there is a small increase in the use of technology in learning [27]. In this case, one indication is that the teacher asks students to use software (eg geogebra) to check the correctness of student answers or the teacher asks students to use excel to represent data in the form of diagrams.

The approach to learning mathematics that integrates technology in order to develop creative thinking skills, which is carried out by teachers is still at the replacement stage, namely technology replaces traditional tools, which do not change learning methods that are relevant to creativity, student learning processes, or curricular goals [13]. Most teachers are limited to using power point instead of a blackboard, using a calculator or graphing software, without changing the learning approach that is relevant to the development of students' creativity.

The teacher's view that technology does not necessarily increase the effectiveness of learning is one of the reasons they are less sure to integrate technology into learning, especially to improve students' creative thinking skills. This finding is in line with the results of research [5] which states that teacher beliefs affect the choice of technology-based learning practices to develop creative thinking skills. Furthermore, teachers have never intentionally designed mathematics learning to develop students' creative thinking skills, both with and without the help of technology. Teachers' knowledge regarding how to assess students' creativity is also still minimal. Also, the teacher's knowledge of creative thinking and creativity in general is correct, creative thinking is the process, while creativity refers to the product. However, there are those who think that students who are good at using certain software (eg photomath) to solve math problems are considered creative students.

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Conclusion

This research finds that the M-FGDs show that teachers frequently define creative thinking as thinking abilities related to divergent thinking, but they rarely connect it to unrelated ideas like creative process, or personal conceptual understanding. As a result, they are unable to suggest a method of evaluating students' creative thinking. Additionally, they hold varying opinions on the need for technology to replace conventional tools, which do not alter the relevant learning processes for creativity, and none of them make the connection between the concept of integration and transformation scenarios. In order to promote students' creative thinking, some pedagogical skills connected to teacher demands for technological mastery and understanding of generating and choosing technology-assisted assignments were suggested.

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Development of a virtual learning environment based on mathematical discourse to support critical thinking skills for junior high school students

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Abstract. *Encouraging critical thinking is one of the goals in 21st-century education that many education systems want to achieve through schools. However, the results of the research show that education at school is not the main factor in developing this kind of higher-order thinking skills. In today's digital era, where the use of technology in learning, such as Virtual Learning Environments (VLE), when designed with appropriate pedagogical settings such as an emphasis on discourse activities, has enormous potential to make students more actively involved in learning. Although several VLEs for learning mathematics have been developed, the emphasis on discourse as a basis for interventions to develop students' critical thinking skills has not received special attention. Therefore, this study specifically aims to produce a mathematical discourse-based VLE for junior high school mathematics learning and determine its effectiveness on students' ability in thinking critically.*

Keywords: critical thinking; mathematical discourse; virtual learning environment; junior high school

Introduction

The promotion of critical thinking education is one of the main goals of education in the 21st century. However, research findings show that the development of critical thinking skills is not seen as a direct product of the process of providing education in schools [1]. This is because schools rarely teach critical thinking skills explicitly [2], even though teaching these skills explicitly is one of the determining factors in improving students' higher-order thinking skills [3,4]. Critical thinking skills can simply be interpreted as thinking skills that focus on making a decision to believe in something and what action to take next regarding that belief [5]. These skills can be taught explicitly through mathematics learning [6].

In the process of learning mathematics at school, it is not uncommon to find students who only trust the problem-solving process demonstrated by their teacher. It is also not uncommon to find students who mechanically imitate the problem-solving process presented in textbooks. The same phenomenon happened at SMP Muhammadiyah 01 Medan where students generally could

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not explain why their solutions were appropriate or not. In addition, the results of the Program for International Student Assessment (PISA) for Indonesian junior high school students in 2018 were quite alarming where Indonesia was ranked 72 out of 77 participating countries of the Organization for Economic Cooperation and Development (OECD) with 379 points below the average and 489 for mathematics competence [7]. This condition needs serious attention.

The learning intervention strategy is a determining factor in the development of student's critical thinking skills [8,9]. Interventions dominated by the teacher's role where students listen more, which does not activate them to ask questions, are the main cause of students' low critical thinking skills [10]. In fact, the development of higher-order thinking skills requires stimulation that creates active interaction between students. This stimulation can be done in the form of discussions and questions and answers about open issues [11]. Active interaction between students can also be carried out through discourse-based learning interventions [12] which are proven to have a significant positive influence on the development of student's critical thinking skills [13]. Thus, explicitly integrating discourse-based intervention strategies into learning in schools needs to be a major concern in developing students' critical thinking skills.

The rapid development of technology is in line with the increasing use of technology in learning, such as Virtual Learning Environments (VLE). If designed in the right pedagogical setting, VLE can be a tool to stimulate students to interact more actively [14] because it provides students with an effective way to learn new skills [15] and gain new knowledge and experiences [16]. An important aspect of creating such learning is the role and participation of teachers and students in virtual classrooms. However, very little literature is devoted to the role of discourse-based VLE in supporting the development of critical thinking, and thus further investigation is warranted.

Several studies have shown that VLE is able to facilitate student discourse [17,18]. This is because this device enables meaningful, contextual, and authentic situations to emerge, and ensures the availability of learning resources for students. Although several VLEs for learning mathematics have been developed (such as [19] and [20]), the emphasis on discourse as a basis for interventions to develop students' critical thinking skills has not received special attention. Therefore, this study specifically aims to produce a mathematical discourse-based VLE for junior high school mathematics learning and determine its effectiveness on critical thinking skills.

Methodology

This research develops a mathematical discourse-based VLE that will be used to support students' critical thinking skills. The research was conducted at SMP Muhammadiyah 01 Medan, a private junior high school in Medan City, in the 2021/2022 academic year. The development process is carried out in four stages, namely analysis, design, development, implementation, and evaluation. Each stage involves two educational experts and two practitioners as resource persons in the Focus Group Discussions. To determine its effectiveness on students' critical thinking skills, the developed VLE was applied to second grade students. Only students who volunteered and had obtained the consent of their parents were involved. The students were matched based on their grade point average in mathematics class, pre-test scores for the critical thinking test, and personal information.

The researchers created a personal information form to see if there were any significant differences in the sociodemographic traits across the groups. In this study, the test previously developed by Firdaus *et al*. [8] was used to collect data on students' critical thinking skills. The

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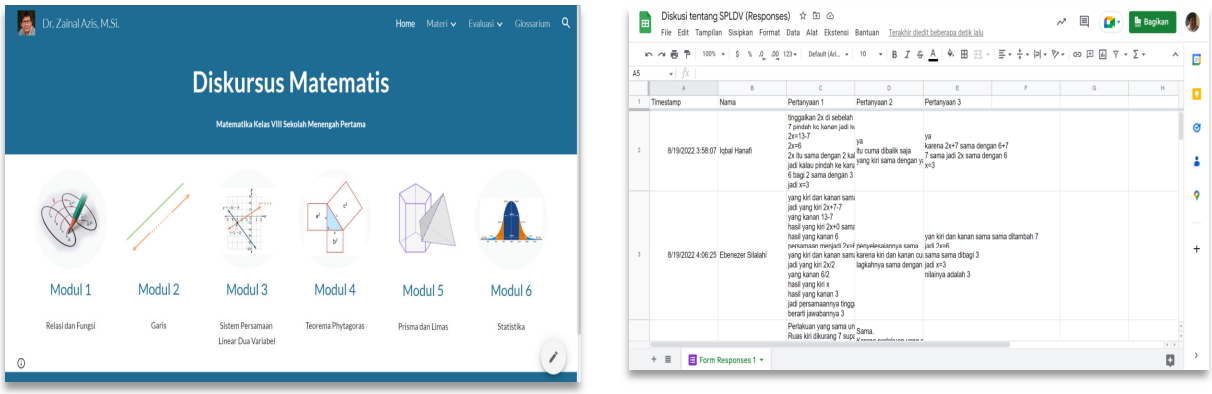
test is translated and written into Indonesian. After going through the examination of linguists, the test was applied to 30 students who were not included in the participants. In the analysis carried out for reliability, the Cronbach Alpha value was found to be 0.73. There were four assessment criteria for student answers to each question in the critical thinking test. If a student writes a complete answer based on the results of his thinking and in accordance with the indicators of critical thinking skills, then the student is given a value of 3 (good). If a student expresses his thoughts incompletely according to the expected critical thinking components, then he gets points 2 (medium). If a student expresses his thoughts in a way that is not in accordance with the expected critical thinking components, then he is given 1 point (enough). If a student does not express his thoughts for each component and standard of critical thinking, then he gets 0 points (bad). Thus, the minimum score is 0 and the maximum score of the test is 51.

The design of this investigation was quasi-experimental with pre-and post-test control groups. Participants were randomly divided into two groups by cluster: the experimental group (n=31) and the control group (n=31). For 16 weeks, the experimental group received 3 hours of discourse-based VLE instruction in geometry every week. The current curriculum was used in the control group.

For the data derived from personal information, frequency and percentage values were computed in the data analysis, and an χ^2 analysis was performed. After the average and standard deviation of students' mathematics scores in the previous semester were calculated, the difference between the mean scores of the sample groups was tested using the Kruskal-Wallis H test. Based on an examination of the pre-test results, the scores obtained by the two groups were normally distributed so t-test analysis was used to assess whether there was a difference between the two groups in terms of pre-test scores. Next, calculations were made of the average of the pre-and post-test scores, standard deviation, post-test adjusted mean, and standard error to perform a covariance analysis of the post-test scores that had been adjusted to the pre-test results. The tests were carried out on the assumptions of ANCOVA.

Results and discussion

After going through each stage in the ADDIE model, discourse-based VLE can be seen in Figure 1 and can be accessed at https://sites.google.com/umsu.ac.id/mathematicaldiscourse.



(a) (b)

Figure 1. The developed discourse-based VLE

Table 1 shows values of the mean and standard deviation of the groups' pre-test and post-

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test scores. The corrected mean post-test scores and standard deviation values calculated for covariance analysis are also shown in the table.

Table 1. The values of mean and standard deviation of the groups' pre-test and post-test scores and the values of corrected mean and standard deviation post-test scores.

Groups	*N*		Corrected Post-test Scores			
			x	SD	Corrected x	SH
Experiment	31	Pre-test	23.25	6.54		
		Post-test	36.01	5.02	36.01	0.70
Control	31	Pre-test	23.47	5.75		
		Post-test	28.32	3.67	28.32	0.70

The average corrected post-test score for the experimental group was found to be 36.01 and 28.32 for the control group, according to the results shown in Table 1. The outcomes of the 2×1 ANCOVA, which was carried out to ascertain whether there was a significant difference between the groups, are shown in Table 2, with the post-test scores adjusted for the pre-test scores.

Table 2. Results of the ANCOVA with Pre-test Score Correction for the Groups.

Source of Variants	Sum of Squares	SD	Mean of Squares	F	Partial	
					p	η^2
Control Group (Pre-test)	294.483	1	294.483	19.447	0.00	0.247
Main Grouping Effect	1006.071	1	1006.071	66.355	0.00	0.528
Error	895.432	59	15.189			
Total	2200.000	61				

There was a statistically significant difference between the groups, as shown in Table 2 ($F(1,59) = 66.355$; $p = 0.00$). This finding implies that the groups' various instructional approaches each had a different impact on the students' mathematical critical thinking. In this study, η^2 was used to gauge the impact's size on students' overall test scores. When assessing the magnitude of the effect, we divided the results into three categories: small effects if the amplitudes less than 0.01, medium effects if the amplitudes between 0.06 and 0.14, and strong effects if the amplitudes greater than 0.14 [9]. As a result, it is clear that the experimental group's strategy has a significant impact ($\eta^2 = 0.528$) on the teaching of critical thinking skills. In this situation, it can be said that 52.8% of the change in the dependent variable is contributed by the intervention strategy with the VLE used, depending on the magnitude of the effect. In conclusion, it was found that the experimental group's educational program had a greater impact on students' mathematical critical thinking skills than the standard curriculum.

Conclusion

This study applies discourse-based VLE as an intervention strategy to both sample groups in a pre-test and post-test quasi-experimental design to investigate its effect on students' critical thinking skills through mathematics lessons. Based on the results of the covariance analysis, there was a statistically significant difference between the two sample groups where the learning outcomes of

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the experimental group were higher than the control group. It can be seen that the discourse-based VLE intervention strategy has a positive impact on student's critical thinking skills.

Acknowledgments

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The effectiveness of mathematics learning in the context of malay culture based on student curiosity

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Abstract. *The relationship between mathematics and culture is known as ethnomathematics, this is an interesting topic to study. Therefore, this study aims to determine the effectiveness of learning mathematics in a cultural context, especially Malay Culture which is reviewed based on the results of students' curiosity. This research was conducted at SMA N 1 Meranti. Theresearcher used quasi-experimentalmethod in this study. The sample of this study was 30 students for the experimental class obtained by cluster random sampling technique. The research instrument was in the form of a student's curiosity quetonnaire. Data collection techniques were obtained after being given lessons on geometry material. The results of the study stated that learning mathematics in the context of Malay culture was effective for students' curiosity. It can be seen from the results of hypothesis testing conducted using the t-test. from the analysis, it was obtained that* t_{count}*=3,231 and* t_{table}*=1,67. This research is showed that* $t_{count} > t_{table}$*, then* H_0 *is rejected and* H_a *is accepted. By the acquisition of the highest score in the curiosity questionnaire, students who were taught in geometry learning were 90 scores of students taught in the context of Malay culture while conventional learning obtained 81 score. Thus, it can be concluded that learning mathematics in a cultural context is effective and can increase students' curiosity.*

Keyword: Malay culture, curiosity, mathematics

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Introduction

Science has been agreed as a means to develop the individual. This can be obtained through the learning process, which is based on the same desire, namely "developing the individual". The popularity of science develops through learning classes in which it is facilitated by someone who is considered capable of communicating knowledge or who is known as a teacher. In its development the teacher as a facilitator must continue to improve learning through various controlled media, so that students can have new knowledge that will attract their interest to develop themselves and can contribute to the current globalization movement.

The success of learning for students can be seen from how students independently through their learning experiences form curiosity, until they can solve a problem. The learning process that confronts students in an interesting media will be positively proportional to the interest of students to continue their curiosity. Schwartz-DuPre & Parmett do the test and find that the children who saw the " Curious George" series better in managing their curiosity, so that their learning process becomes better[1] Series "Curious George" is a cartoon series featuring primates who have a great curiosity about science. And in fact this media is very influential for the children who see it.

Curiosity was actually developed in 1977 by Edge and in 1989 by Herlen. In scientific research they explore how curiosity affects memory[2]. Even the OED defines curiosity as a disposition to investigate things thoroughly[3]. Mathematics as a science certainly requires accuracy to investigate a problem. On this basis the ability of a student to research (especially in learning mathematics) through curiosity must be helped to be developed. Because[4]curiosity cannot arise on its own initiative, but it needs help to be honed and trained so that it can grow well. Curiosity can be honed by getting used to giving students challenging problems. Especially in the current era of globalization where information is widely open, so that students can be trained to see problems from a broad perspective as well[5]. This will help students generate a variety of questions in themselves. This opinion is in accordance with what was expressed [6] by who said that curiosity can make people motivated to find out about new things so that they can add knowledge and new learning experiences.

Educational psychologists have also found ample evidence that curiosity enhances learning. Students who develop their curiosity will enjoy exploring and accumulating the knowledge they have acquired. Aspects of student ability such as self-motivation, collaborating with other students, asking questions, doing math outside of class requirements based on curiosity. Or it can be said that inquiry and curiosity are closely related[2]. Curiosity related to other personality traits can influence different levels of intelligence across cultures and across life stages of development[3]. For this reason, especially in learning mathematics, curiosity can make students motivated to explore and find answers to the problems given. From several explanations, definitions, characteristics and research that have been stated above, the indicators of curiosity in this study are: (1) Asking about the information or problem provided; (2) Desire to know things in detail; (3) Enthusiasm /enthusiasm in learning; (4) Seeking information from various sources; and (5) Trying alternative solutions to the problem[7].

[7],[2]identify two aspects of curiosity, namely: (1) Dispositional curiosity (character quality) namely curiosity that refers to the quality of a person's self to train himself to act in certain ways so that curiosity stably; and (2) Situational curiosity (the right situation) is curiosity that arises from the influence of internal or external activities that have been or are currently happening that allow interaction between people and the environment.

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The learning process that involves people with the environment has proven to be successful in generating curiosity. In this case the environment can be associated as a culture that lives in society. In line with that, education that is integrated into culture is believed to be able to create more meaningful learning through experiences that students encounter in everyday life, so that students have an attitude of respect and can develop curiosity, tenacity, and confidence in learning mathematics[8]. Teachers often take far steps to improve students' Curiosity in the learning process, such as innovating learning through technology media. Whereas culture can be used as a "friendly" medium to be taught (simple and close to student life). By popularizing science in the field of culture will encourage young people to " be curious" . Icon culture is a stable object that can adapt over time. This is familiar in the community through repeated story telling and drama and plays an important role in upholding cultural values. Iconicity allows it to be instantly recognized and imitated. Cultural icons can popularize ideology and teach individuals, in this case students [2].

According to the KBBI, culture is the result of thought or reason. In line with that, Mathematics is seen as the result of human reason and is considered as the result of abstraction of the human mind [9]. On the basis of this similarity, mathematics and cultural education are a unified whole that cannot be separated . Because both have the same essence, namely increasing the potential that exists in humans[10]. Seeing also that education is currently in the era of globalization and modernity, local culture as one of local wisdom is something that must be maintained and developed [9]

In fact, based on initial observations at SMA N 1 Meranti through interviews with teachers, it was shown that students did not have the motivation to take part in classroom learning and were very less enthusiastic about solving the problems given. According to the information obtained, this is due to several factors, especially teacher-centered learning. In addition, their enthusiasm is low as a result of students who think that mathematics is not in harmony with their lives. Therefore, there is a need for a new innovation to be included in the mathematics learning process at the school. One of the innovations offered is culture-based mathematics learning. The culture adopted is Malay culture, because the Meranti area is still in an environment that is thick with Malay culture.

The term “Malay” comes from the words “mala” (which means the beginning) and “yu” (which means country). Malay culture is a complex whole that contains science, belief, art, morality,laws, customs and others. This is an ability and habit acquired by humans as members of society[11],[8]. The Malay tradition has a vital force that requires humans to become individuals who have vision, imagination, and creativity. However, Malay culture still seems to have received less response from some educational institutions to be realized in learning. The Malay tradition seems to put forward the principles of being diligent, independent, working hard, tolerant and polite. So that individuals who are part of it have the opportunity to develop and find the best for themselves[12]. In this case, Malay culture is reviewed from 4 aspects[11]:

a. Cultural Facts: concrete objects and Malay environment that can be used as a source of mathematical problems as inspiration and abstraction of various concepts and principles in mathematics.
b. Social system: patterns of social interaction through deliberation, open-minded attitudes and patterns, mutual cooperation, likes to dialogue, and being independent .
c. Cultural system: crystallization of the values of deliberation in making decisions, being diligent , independent, and working hard

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d. Value system: the value of Malay education in the form of advice and mindset used in behaving, acting, working and adapting to the surrounding environment in a tolerant and polite manner.

If curiosity is believed to be an encouragement or a positive attitude to encourage individuals to produce new and productive knowledge, the teacher as a facilitator must be able to realize the positive personification of curiosity. Positive personification in this case will be associated with local culture[13]. For this reason, the culture taken is Malay culture because it is close to the lives of students at SMA N 1 Meranti. On this basis, it appears that Malay culture is in line with the concept of Curiosity which is related to daring to seek, daring to try, having enthusiasm, having a strong desire and having great enthusiasm so as to provide opportunities for individuals in this case students to develop themselves. Because of these advantages, learning Mathematics in the concept of Malay culture is expected to be able to foster student curiosity.

Methodology

This study uses a quasi-experimental method (quasi-experimental) in this study the samples were grouped into two, namely the experimental class (culture-based learning class) and control class (class given conventional treatment). The experimental design used in this study is in the form of *two groupsrandomized subject posttest only* means randomized control by giving a questionnaire only at the end of the treatment. This can be seen from the design below:

Table 1. Design of two groups randomized subject posttest only

Experimental	**R**	**X**	**O**
Control	R		O

Source[14]

The target population in this study were all students of SMA N 1 Meranti. While the affordable population is class XI students. The results of the selection of class random sampling, the sample in this study was selected in class XI B is the experimental class and class XI C is the conventional class.

Data analysis in this study was using the Curiosity questionnaire instrument consisting of 5 indicators; (1) Asking about the information or problem provided; (2) Desire to know things in detail; (3) Enthusiasm/enthusiasm in learning; (4) Seeking information from various sources; (5) Try alternative solutions to the problem .

Results and discussion

Description of the Curiosity Questionnaire Results was conducted after learning based on Malay Culture was given as many as 30 statements with 5 indicators, namely: (1) Asking about the information or problems provided; (2) Desire to know things in detail; (3) Enthusiasm/enthusiasm in learning; (4) Seeking information from various sources; (5) Try alternative of solving the problem. For more details, the Curiosity indicators for each class can be seen in the following figure:

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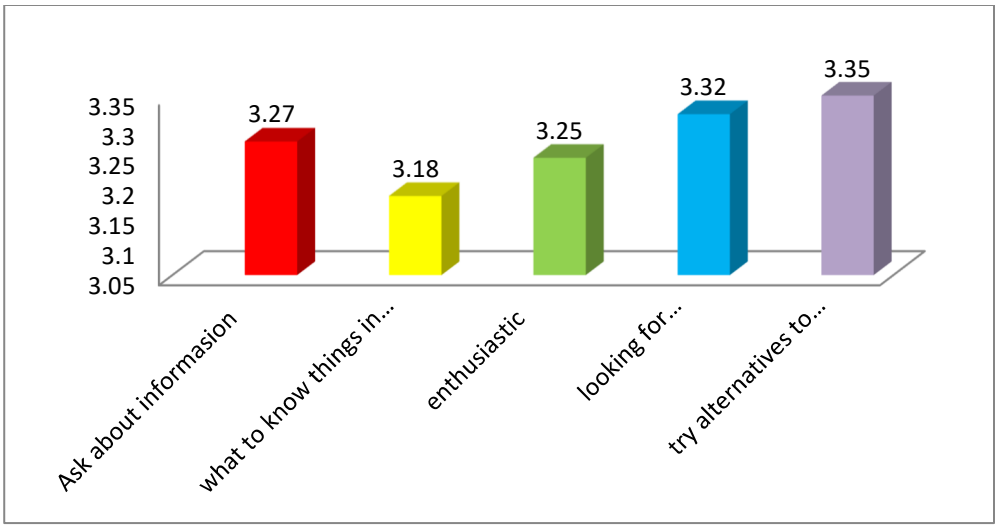


Figure 1. Percentage of curiosity of student indicators in experimental class

Figure 1 shows the average for each indicator, namely: Asking about information (3.27); Desire to know things in detail (3,18); Enthusiasm (3,25); Looking for information from other sources (3,32); Try alternatives to troubleshooting (3,35). Furthermore, for Curiosity's averagestudents with conventional learning clearly the indicators can be seen in Figure 2 below:

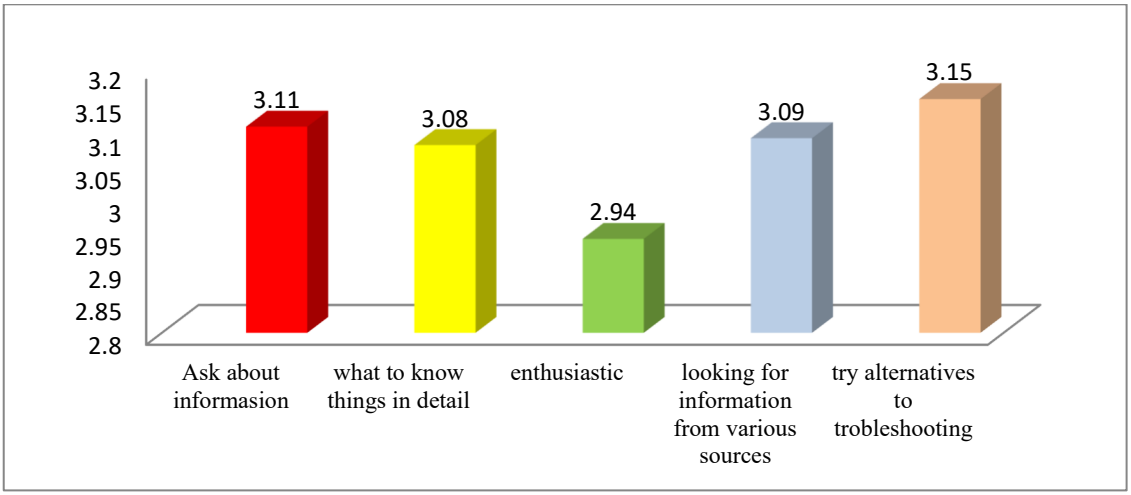


Figure 2. Curiosity percentage student indicators in control class

Figure 2 shows the average for each indicator, namely: Asking about information (3.11); Desire to know things in detail (3,08); Enthusiastic (2,94); Seeking information (3,09); Try alternatives to troubleshooting (3,15). Based on the percentage of Curiosity in the two classes, there are several Curiosity indicators that are superior to the experimental class and the control class, but if you look at it in detail, the Curiosity of students in the experimental class is still superior to the control class, the highest score, average score and standard deviation of each experimental and control class, as summarized in Table 2 below:

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Table 2. Curiosity score recapitulation

Descriptive Statistics					
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Ex	22	72	9 0	8 2 ,00	5 , 67
Cont	24	6 4	8 1	77.0 0	4.5 2

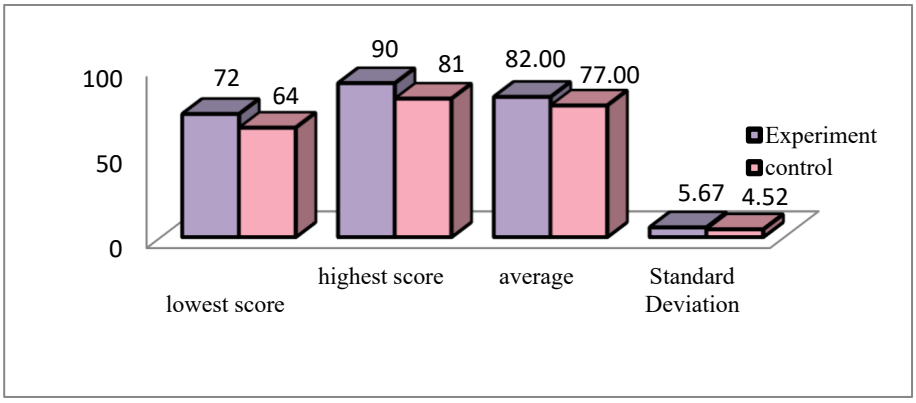


Figure 3. The curiosity questionnaire average score for the experimental group and the control group

In Table 2 and Figure 3 it can be seen that Curiosity in the experimental class obtained an average of 82,00 with a standard deviation of 5,67 , the minimum value = 72 and the maximum value = 90 . While Curiosity for the control class given conventional learning obtained an average of 77,00 with a standard deviation of 4,52 , the minimum value = 64 and the maximum value = 81 . Furthermore, quantitative student Curiosity can be seen in Table 3 and Table 4.

Table 3. Quantitative experimental class student curiosity score interval

No	Score Interval	Total students	Percentage	Category Appraiser a n
1	X >84%	5	16,66%	Very Decent
2	69 <X ≤84%	19	63,33%	Decent
3	54% X ≤69%	6	20%	Sufficent
4	39 X < 54	0	0%	Less
5	X 39%	0	0%	Very less

Table 4. Curiosity control class students quantitative conventional learning

No	Value Interval	Total students	Percentage	Category Appraiser a n
1	X >84%	0	0%	Very Decent
2	69 <X ≤84%	14	58,33%	Decent
3	54% X ≤69%	7	29.16%	Sufficent
4	39 X < 54	3	12,5%	Less
5	X 39%	0	0%	Very less

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From Table 3 and Table 4 Curiosity of students in the experimental classit was found that, the number of students who scored very less was 0 people or 0 %, who had a poor category of 0 people or 0 %, who had a sufficient category value of 6 people or 20%, who had score decent category as many as 19 people or 63,33 %, which has a vey decent category value of 5 people or as much as 16,66%. Meanwhile, for Curiosity students in conventional learning classes , it was found that, the number of students who scored very less was 0 people or 0 %, who had a less category of3people or 12,5% , who had a sufficient category value of 7 people or 29,16 %, which has a decent category value of 14 people or 58,33%, which has a very decent category value of 0 people or 0%. For more details, see Figure 4Curiosity level of students in the following experimental and conventional classes :

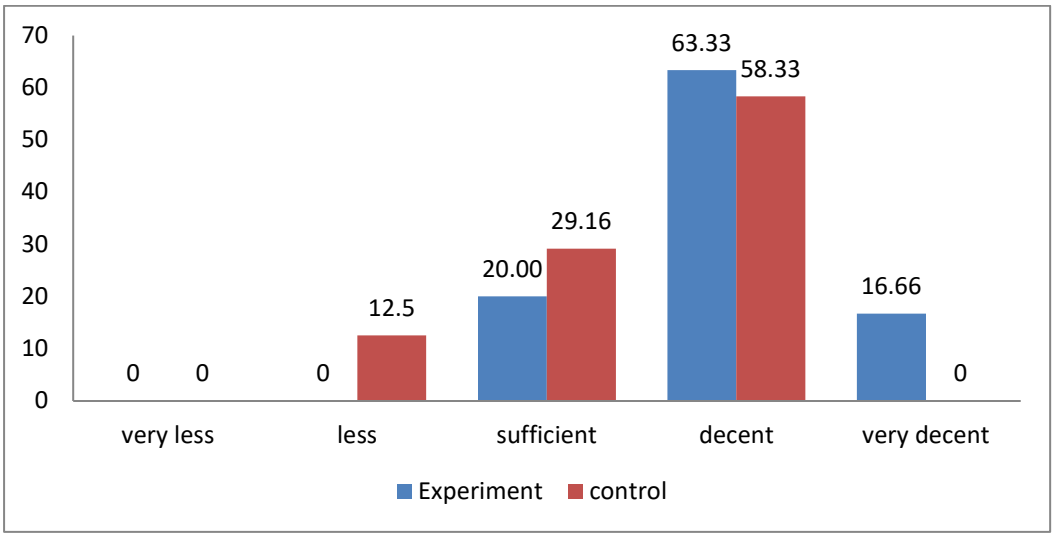


Figure 4. Percentage of curiosity of students in experiment class **and control class**

Inferential statistical analysis of students' Curiosity test results was shown to test hypotheses, namely: (1) there was a significant influence between culture-based and conventional learning on students' Curiosity. Statistically, it is still necessary to test the significance of the effect using the t-test statistical test, before using the t-test statistic, the conditions must first be met, namely normality test, homogeneity test, Based on the results of the test requirements that have been met, then to test the significant effect of Curiosity between students given the Malay culture-based learning and conventional learning can be analyzed by t-test .The hypotheses to be analyzed are as follows:

Hypothesis testing for curiosity students

Hypothesis testing with t test can be calculated using the formula:

$$t = \frac{\overline{X}_1 - \overline{X}_2}{S\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \qquad (1)$$

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Testing the formulated hypotheses used t-test analysis using F statistics with the formula and criteria set.The results of the calculation of the analysis of hypothesis testing using the t test at a significance level of = 0.05 obtained t_{count} of 3.23 while t_{table} of 1.79. Because $t_{arithmetic} = 3.23 > t_{table}$ 1.67 so H_0 is rejected. It can be concluded that there is a significant effect of learning mathematics with the concept of Malay culture on students' Curiosity .

Conclusion

Based on the results and discussion, the following conclusions were obtained: from the five curiousity indicators, the highest indicator was obtained from the two classes, namely the indicator 'Trying alternatives to problem solving' while the lowest indicator in the experimental class was obtained from the indicator 'Want to know things in detail' and in the control class obtained the indicator 'enthusiasm'. Besides thatThe results of hypothesis testing obtained t_{count} of 3,23while t_{table} of 1.67. Because $t_{arithmetic} = 3,23 > t_{table}$ 1.67 so $H_{0\ is}$ rejected. Then it can be concluded thatLearning that uses the concept of Malay culture can create learning effectiveness in the classroom so that it affects the curiosity of students in class XI SMA N 1 Meranti.

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Improving self-regulated learning through the wolfram alpha in mathematics learning

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Abstract. *The development of the world of education today is very dependent on technology. Research that is often done lately is to link learning with the latest technology that promises convenience and effectiveness for students. Besides being able to support the learning process, technology can also increase self-regulated learning. There have been many studies that discuss the use of applications in learning, but research with the help of Wolfram Alpha applications is still rarely found. The purpose of this study was to determine whether learning mathematics with the help of technology, namely the*

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Wolfram Alpha application, could increase self-regulated learning. To answer the research objectives, the researcher used a quantitative approach involving a sample class of all students at the Dharma Jaya Middle School in Medan. The instrument used in this study was a learning independence scale consisting of 20 statements. While the treatment during learning makes use of technology, specifically the Wolfram Alpha application for solving problems in student worksheets. The results showed that 1) the average final score of self-regulated learning was higher than the average initial score of self-regulated learning, namely the average final score of 91.19, while the average score at the beginning was 69.48, with a difference of 21.71. For the average increase (N-gain) obtained by 0.69, according to Meltzer, the value is in the medium category. So learning mathematics using the Wolfram Alpha application can increase self-regulated learning. From the results of the study, it is known that the application of technology, namely the application of Wolfram Alpha in learning mathematics, can increase students' interest in learning, and with the help of technology, learning becomes more fun. Furthermore, with technology, students are encouraged to study independently.

Keywords: Technology, self-regulated learning, education, mathematics

Introduction

Students require self-regulated learning during the learning process. According to Law Number 20 [1], one of the goals of national education is that students be required to have self-regulated learning. If students have self-regulated learning, then they have the freedom to think, be skilled, and be creative when faced with a problem. In addition, if self-regulated learning is embedded in students, then they have confidence in their own intellectual abilities and will be actively involved in the ongoing teaching and learning environment. This situation can improve their learning outcomes. This is related to a study by Fauzi [2], which states that cognitive development is strongly influenced by self-regulated learning, continuous motivation, and an unyielding spirit. Thus, learning independence is needed to improve student learning outcomes. Furthermore, the opinion of Bungsu et al. [3] states that self-regulated learning is needed in learning mathematics.

Based on this opinion, it is necessary to develop self-regulated learning, which is useful for fostering creativity and skills in students. According to Benson [4] "independence is the ability to supervise students themselves, so that independence reflects awareness in meeting their own learning needs in order to acquire certain knowledge and skills." So self-regulated learning is an important thing that students must have. However, in the initial observations made at one private junior high school, information was obtained that students, when working on questions, always asked the teacher to complete the same example as the questions to be worked on. In addition, students must always be supervised when working on questions. If they are not supervised by the teacher, they will cheat their friends. From this picture, when reflecting on the learning process that has taken place so far, the teacher usually gives the material first, then the example questions are worked on together. Then, they are given practice questions with the same pattern as the example. This makes students' dependence on the teacher quite large because all the materials needed to solve the problem can be provided by the teacher. Sari et al. [5] explained that the lack of innovative mathematics learning methods that have been taking place so far has caused students' abilities to not develop in the problem-solving process. In addition, the results of the study Kamarullah [6] stated that the mindset that states that mathematics is a difficult subject to understand makes students have a tendency to be afraid, which results in poor grades in mathematics compared to other subjects.

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So overall, a temporary assumption can be drawn that self-regulated learning is still very low, and this is a serious problem that must be addressed immediately. The description above illustrates that students need to develop self-regulated learning to learn mathematics. Self-regulated learning will be strengthened if technology and information are used in learning mathematics, for example, learning via the internet or e-learning, which has the advantage of providing several facilities, such as updated library resources and unlimited access. Hoyles & Lagrange [7] assert that digital technology is the most influential thing in the education system in the world today. This is due to the aspects of effectiveness, efficiency, and attractiveness offered by digital technology-based learning. If in the 1980s, artificial concrete objects dominated their use as a visualization tool for abstract concepts, now digital technology-based visualization is widely used as a tool that is more effective, efficient, interactive, and attractive. If in the 1990s, the use of digital-based calculating tools, such as calculators, was avoided in schools due to the assumption that these tools could damage students' mental math, now calculators are seen as having educational value to improve students' abilities, their number sensitivity, and their ability to solve math problems. NCTM [8] says that integrating technology into learning has at least three positive effects on math learning: technology can help students do better in math, technology can make math teaching more effective, and technology can change what and how math should be learned and taught.

In line with NCTM [8], various studies show that students can learn mathematics more richly and deeply when technology is used "effectively" in mathematics learning [9-12]. Information technology-based learning innovation begins with the use of computers in offline learning and then develops with the use of the web in online learning [13]. The use of computers through virtual laboratories in science learning is very beneficial because it can provide broad opportunities for students to develop their abilities in investigation and analysis, as well as form new knowledge and understanding and find ways of solving problems through learning [14]. The availability of complete facilities on the web facilitates the search for teaching materials quickly, so there is a great opportunity for students to learn all the materials they need [15]. The use of information technology that is integrated into teaching materials can encourage a shift in learning from conventional learning to independent learning for students [16].

The use of technology in mathematics learning has been widely carried out. In this study, we discuss how the use of technology in mathematics learning can attract students' interest in learning and can support the teaching and learning process in the classroom for the better [17-21] The use of appropriate and varied learning media can overcome the passive nature of students. Media can increase the spirit of learning, allow students to learn on their own based on their interests and abilities, and allow direct interaction between students and the environment and reality [22].

From the above explanation regarding the use of technology in learning, there are some that can increase student learning independence. So in this study, the focus is on using the WolframAlpha application to make it easier for students to trace the solutions to the problems or questions given, and with this application, it is hoped that students can become independent learners. So the formulation of the problem in this study is whether learning mathematics with the help of technology, namely the Wolfram Alpha application, can increase student learning independence?

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Methodology

To respond to the formulation of the problem in this study, a quantitative method involving a sample of the entire population of class VIII SMP Darma Medan was used. The instrument used is an attitude scale in the form of a statement of 20 items that refers to the Likert scale [23] as shown in the following table:

Table 1. Likert scale category score

Direction	Very	Agree		Not	Very not
Statement	Agree		Neutral	Agree	Agree
Positive	5	4	3	2	1
Negative	1	2	3	4	5

The research data came from the provision of a learning independence scale at the beginning and end of learning, namely learning to solve problems using technology in the form of Wolfram Alpha applications. To see the increase, the normalized gain/N-gain formula is used[24], with the normal gain category (g) according to Meltzer [25] being: g< 0.3: low; 0.3< g< 0.7 : medium ; g >0.7 : high.

Result and discussion

The purpose of this study was to determine whether learning mathematics with the help of technology, namely the Wolfram Alpha application, could increase student learning independence. The data in this study were obtained through the provision of an attitude scale in the form of a student learning independence scale. This study involved a class of 27 students learning mathematics using the Wolfram Alpha application. The instrument was given twice: at the beginning of learning (before the learning process was carried out) and at the end of learning (after the learning process with treatment using the wolframalpha application). The attitude scale given is 20 statements with a maximum score of 100. The following table shows the results of giving an attitude scale at the beginning and at the end of learning obtained from 27 students, with the N gain category referring to Meltzer [25].

Table 2. Score data for each student

Number	Beginning score	End Score	N Gain	Category
1	68	93	0.78	high
2	62	92	0.79	high
3	76	89	0.54	middle
4	59	90	0.76	high
5	60	83	0.58	middle
6	59	89	0.73	high
7	69	91	0.71	high
8	65	93	0.80	high
9	77	94	0.74	high
10	84	90	0.38	middle
11	83	96	0.76	high
12	67	92	0.76	high
13	68	93	0.78	high

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14	63	93	0.81	high
15	62	85	0.61	middle
16	78	84	0.27	low
17	71	96	0.86	high
18	87	98	0.85	high
19	68	94	0.81	high
20	72	90	0.64	middle
21	67	92	0.76	high
22	56	96	0.91	high
23	68	99	0.97	high
24	66	84	0.53	middle
25	70	89	0.63	middle
26	70	93	0.77	high
27	81	84	0.16	low

Based on the table above, the average value and standard deviation of the initial, final, and N gain values are obtained. For more details, see the following table.

Table 3. Self regulated learning scale data

Attitude scale	Max Score	X_{max}	X_{min}	Average	Standard Deviation
Beginning score	100	87	56	69.48	8.12
End Score	100	99	83	91.19	4.34
N-Gain	100	0.97	0.16	0.69	0.19

In the table above, it can be seen that the maximum score is 100 and the average score at the beginning of learning is 69.48, while the score at the end of learning is 91.19. There is an increase in the average score between the initial and final learning scores of 21.71. Furthermore, for the value of the increase or N-gain obtained an average of 0.69. According to Meltzer [25] the value for the gain is in the medium category, namely at the interval 0.3 N-Gain < 0.7: moderate. For more details, it can be seen in the following graph

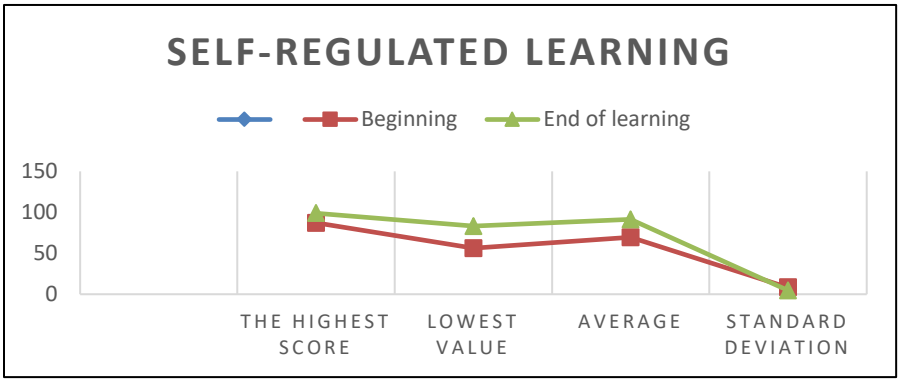


Figure 1. Graph of self regulated learning scale

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From the description above, it can be seen that there is an increase in the student attitude scale score of 21.71. Thus, the purpose of this research has been answered, namely, that learning mathematics with the help of Wolfram Alpha application technology can increase student learning independence. Based on observations in the field, besides being able to increase student learning independence, it turns out that by using the WolframAlpha application, there are several benefits, including:

1. The Wolfram Alpha application can be used as a tool for solving mathematical problems.
2. With this application, students can be trained in mastering math subject matter.
3. Using the Wolfram Alpha application can save time when working on questions.
4. Using this application can also attract students' interest. Students become more enthusiastic about learning because they use laptops or other gadgets.
5. Students find it easier to operate the Wolfram Alpha application using gadgets because gadgets are close to their daily lives.

In addition to the benefits obtained, there are also several obstacles during the learning process using this application, including:

1. inadequate school facilities; limited availability of laptops and wifi networks
2. Because the network is disrupted, students are slow to access the application.
3. Of the 5 study groups, there is one that has difficulty using the application because they are not used to using laptops, so they are awkward and a little afraid.

Conclusion

From the results of the study, it can be concluded that: The average score of student learning independence through learning with the help of the wolframalpha application has increased at the end of learning, namely the average score at the beginning of learning is 69.48, while the average score at the end of learning is 91, 19, there was an increase in the score at the beginning of 21.71. Furthermore, for the increase in /N-gain obtained by 0.69 and is included in the medium category. So the increase in student learning independence using the wolframalpha application is in the medium category. Besides being able to increase the independence of students learning by using the wolframalpha application in learning mathematics has benefits including students feel very fun learning to use technology and learning with applications can be more effective and efficient.

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Exploration of javanese culture in mathematics learning the junior high school

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Abstract. *Exploration of culture in learning is an important thing to carry out. Exploration is an act of searching or exploring with the aim of finding something that is the target or object being studied. In this article, we will discuss the exploration of Javanese culture in mathematics learning in junior high school. Exploring culture in mathematics learning aims to create a meaningful learning process, with the hope that the atmosphere of mathematics learning can run effectively and students can change the mindset that initially stated that mathematics is difficult to become mathematics is very fun. This paper intends to outline*

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the findings from the investigation of Javanese culture that can be used to math education. Investigative studies are utilized as part of the qualitative research methodology. In connection with this research, researchers tried to explore information through literature, observations (observations) and it was possible to have an interview process with several figures or residents of the Javanese community who knew information about the object to be excavated. The results showed that there are many Javanese cultures that have the potential to help learn mathematics in terms of artifacts such as traditional food, traditional games, batik, and others, while in terms of minifak such as wedding ceremonies, birth welcoming ceremonies, and so on.

Keywords: *exploration, culture, mathematics learning, junior high school*

Introduction

Bhinekatunggal Ika (different but still one) slogan that is always attached to the State of Indonesia. A country that has a variety of cultures, spread from Sabang to Merauke. Each tribe, region must have its own culture that makes their identity. The Central Statistics Agency in 2013, has written that Indonesia has at least 633 large tribes. Whereas if it is described in sub-tribes it consists of 1331.

The Javanese are one of the tribes that have an impact on the cultural diversity that exists in Indonesia. Many relics from the Javanese tribe as released by the Statistics Agency in 2016 stated that there are 271 cultural heritages, 1079 intangible cultural heritages, and 912 beliefs and traditions spread across Central Java, Yogyakarta, and East Java. The Javanese tribe's culture, values, and traditions can be utilized as a teaching tool, particularly for arithmetic lessons. This approach involves the creation and use of mathematical ideas based on issues that arise in daily life [1, 2]. In addition reinforced that mathematics is one of the knowledge that cannot be separated from activities in human life, in other words, human activities are inseparable from mathematical activities [3,4]. Even without realizing it, many human activities are part of mathematics [5;6]. In other words, mathematics cannot be separated from the culture that has been attached from ancient times to the present.

Mathematics is one of the learnings that is considered difficult for students to understand. It is not unfamiliar to ask students about mathematics so that it causes a sense of not wanting to learn it. Abstract mathematical concepts that require a strong understanding to be able to solve problems. The learning process that has been going on is also very monotonous, still using conventional methods, less relevant to daily life. The learning process that takes place must relate mathematical material to concepts that are relevant to everyday life. According to Freudhental (1991), mathematics is a human activity and must be connected to human existence. The behavior of students who are unable to apply mathematics to address problems in daily life is the starting point for society's rationale that mathematics has nothing to do with culture or with daily life [7,8].

However, most people still think mathematics is something difficult. This is reinforced by the results of the Trend in International Mathematics and Science Study (TIMSS 2015) which shows that Indonesia is ranked low. In TIMSS 2015, the level of student achievement in mathematics was ranked 45 out of 50 countries with a score of 397 points. In addition, in the TIMSS results, it is also known that 66% of Indonesian students claim to really like mathematics. However, when students are asked to answer questions about confidence in their mathematical abilities, only 23% are confident. This percentage is still relatively low when compared to other countries.

Based on the findings of the PISA (Programme for International Student Assessment) survey, which Stacey [9] evaluated, it may be inferred that Indonesian students are less adept at applying

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mathematical ideas to real-world problems. Because teachers could not make connections between mathematics and culture and everyday activities during the teaching process at school, students have not been able to employ mathematical concepts to solve everyday problems [10,11,2]. This has motivated scholars to look for a mathematical teaching formula that is similar to human action.

There is a direct connection between mathematics and culture. Ethnomathematics can be used in specific contexts to connect the relationship between mathematics and culture [12]. Understanding the connection between mathematics and culture is the goal of ethnomathematics, which aims to make mathematics more understandable for students and the general public [13]. In order to better understand anthropological culture (ethnography), mathematical modeling, and mathematics itself, it is important to study ethnomathematics.

Many of the cultures, especially Javanese, that are not understood by the public, turn out to have a lot of intersection with mathematical material. Therefore, this research takes a role to explore ethnomathematics on marriage customs that exist in the culture of the Javanese people and the cultural values contained in them. It is hoped that the results of this research can be used as a context in making mathematics learning designs, so as to create a mathematics learning design that is fun, close to the daily lives of students, and contains cultural values that can shape the character of students when applied in the classroom.

Methodology

This research was only conducted in North Sumatra, the informants were javanese ethnic people who came from native Java but had settled for a long time in the North Sumatra region. This research uses a descriptive qualitative type of research as a type of research to uncover and obtain information thoroughly, broadly and deeply [14]. In this study, ethnographic methods were used as a research method. The research instruments used are observation sheets, interview sheets containing lists of questions that will be asked to informants, documentation (books that discuss Javanese customs). The data collection techniques carried out are:

1. Observation Stage. Researchers make direct observations when the traditional procession is carried out and take place to follow and observe things that are happening in the field related to mathematics
2. Interviews are conducted by following the indicators of the questions needed as panelist data. Interviews were conducted by researchers by visiting directly informants who were used as accurate sources who understood Javanese culture. Researchers interviewed a Javanese ethnic group who came from Java and understood Javanese culture well but already lived in North Sumatra.
3. Documentation. Researchers here use literature reviews, articles that discuss Javanese culture.
4. Creation of field notes to obtain ethnographic descriptions. Researchers here act as observers and disfigure things that happen and become the data needed for research. Which part of the customary steps occur which are related to mathematics.

Result and discussion

In this study, an exploration of ethnomathematics was carried out in the culture of the Javanese people, especially in the marriage customs that exist in that culture. According to Ambarwati [15] systematically the Javanese traditional marriage ritual basically contains several parts, namely as follows:

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1. Nontoni

It involves getting a close-up view of the prospective bride. Consider it a sign of the two families—the bride's and the groom's—becoming friends. The purpose of performing this practice is to get to know one another better. Technically, there are many different ways to carry out the succession of watching. Some ask their brother or parents to come over to the woman's home. The woman was then instructed to serve beverages by her parents after the visitor had been seated. The man first saw and met the woman who would become his wife at this point.

Nontoni in Javanese customs contains elements related to artifacts related to building space. At this stage the bride will serve a drink that uses a glass from the ground in the form of a building space. Here we can make an overview and calculate the inside and content in the building of the space.

2. Petung (calculation) weton or salaki rabi

It serves as a guidance for choosing a partner based on name, day of birth, and neptune. There is a purpose for using Primbon Betal Jemur to determine salaki rabbi. When using primbon, the value of the script is combined with the names of the bride and groom before being split by five. The remainder of the division turns into the poster child for the arranged marriage. The calculation of the birthdate and neptu comes next. The two potential couples' birthdays are merged so that the combined meaning can be understood. From Silvia, et al., the following information regarding weton calculation in Javanese culture is taken:

Table 1. Calculation of days on the gregorian calendar

Day	Number
Monday	4
Tuesday	3
Wednesday	7
Thursday	8
Friday	6
Saturday	9
Sunday	5

Table 2. Java day market

Pahing	9
Pon	7
Wage	4
Legi	5
Kliwon	8

From Table 1 and Table 2 we can example how to do weton worship to determine the good day of holding a wedding as a gift:

For example, Andi was born on Monday Pon, so it can be calculated as a good date:

$$\begin{array}{ll} \text{Monday} & = 4 \\ Pon & = 7 \\ \hline & 11 \end{array} +$$

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So the resulting number of 11 is the weton date which is considered in Javanese culture as a good day to do various good events such as weddings. From this culture, the mathematical concept is the basic concept of calculation in the form of summation.

3. Tratag roof

A tarub (tratag) is typically erected by the family of a man or woman who is getting married as a formal declaration that a celebration will be held. The phrase "set out ben ketok murub" refers to a tarub that has been made to appear opulent and radiant in order to signal to the neighborhood that a family is celebrating a manten festival. In tarub pairs there are several shapes that contain flat build elements. As seen in the image below:

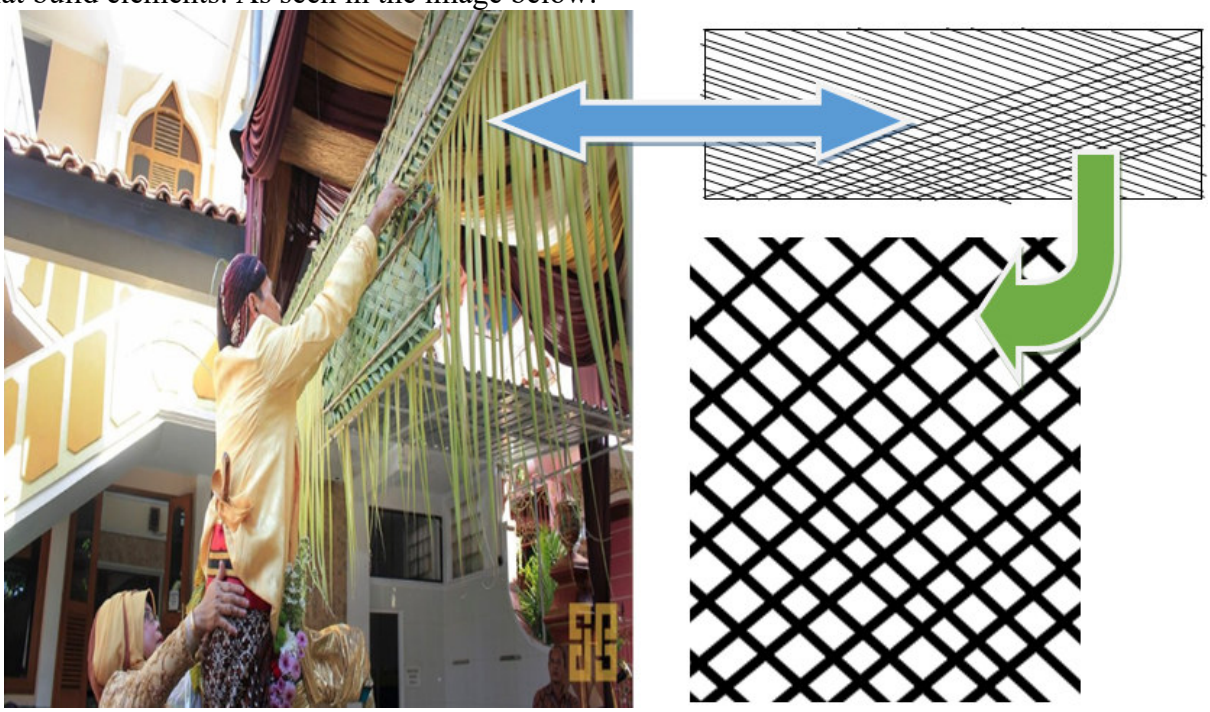


Figure 1. Tratag roof on installation of tarub manten

Figure 1 clearly shows that the tratag roof on the tarub installer contains some mathematical elements for its rectangular outer bone and rhombic webbing. We can use this as a learning medium while showing that the element of mathematics is entirely present in our daily lives, only we do not observe. In the installation of tarup there are rules in determining the length and width of the chicken because it contains sacred elements. Therefore, here we can teach about the length, circumference, area of a flat building.

4. Handover

It is the process by which the groom's family gives goods to the bride's family. In this ritual, there is a process of talking about the continuity of the wedding event between the two families of the bride and groom. In general, the handover contains a full set of clothes, jewelry, rice, coconuts, household tools, livestock and some money. The tradition of handover aims to help prepare for weddings as well as some items that have philosophical value as well as hope in God. The

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relationship between sesah-serahan and mathematics is found in the matter of units of weight and systems of linear equations. Where at the handover a man gives jewelry with a weight that has been mutually agreed upon.

5. Flush

Flushing comes from the word "flush" which means to bathe the bride-to-be so that the bride-to-be is clean, holy and inward. The flushing ceremony is carried out during the day with several pinisepuh (people who are aged/respected) in a family to carry out the flushing ceremony with the bride's parents at her home. Furthermore, the bride-to-be wearing batik cloth and accompanied by officers (usually makeup artists) held sungkem first to her parents and to the family pinisepuh who bathed. After that, the bride goes to the bathroom or other place that has been arranged to carry out the ceremony. The number of people bathing is usually odd or not even. In turn, the pinisepuh poured water on the bride and groom. The last party to do the flushing is the bride's parents. Usually the parents of the bride and groom pour water just a little, this water is not bathing in the true sense, but as a symbolic symbol of physical and spiritual cleansing so that the mind becomes clear.

Flushing is usually done using coconut shells, which are used as dippers to carry out watering. So that the relationship between water and mathematics is found in the dipper, which is the pda of space building matter. Where the dipper is in the shape of a half-ball. And usually the flushing is not only done by the parents, but the older or married relatives also do the flushing which aims to ask for prayers so that the marriage that is carried out becomes a blessing.

Usually the relatives who will water are odd in number. A total of 7, 9 or even 11 flushes. So that the flushing process is also related to learning the odd number operating system.

6. Mayang twins

In Javanese tradition, it is one of the wedding ceremony's accessories. Mayang twins are decorated with strands of flowers, fruits, and leaves in addition to janur, a young coconut leaf arrangement. Twins are two identically sized and shaped items. Twins are vital to the bride and groom's philosophy of life since they serve as a tree of life that can fulfill all of their needs. Megar Mayang or Gagar Mayang, names given to Mayang twins that refer to the blossoming of betel nut flowers Its purpose is to bring in a new era of adults in society so that bhakti and dharma might be reaped by all.



Figure 2. Mayang twins

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The relationship between Kembar Mayang and mathematics is to use the study of geometry, such as one-dimensional geometry and two-dimensional geometry. The study of geometry in Javanese traditional ceremonies, there are Mayang twins in the shape of a triangle.

7. Midodareni night or tirakatan night

It is how guests practice wungon, also known as lek-lekan, which means not sleeping. The intention is for the angels to descend from the kahyangan and pray for the bride-to-be's blessing. As a result, midodareni night is a solemn and quiet time when guests and future devotees' families each pray to God Almighty for salvation for all invited families and guests. All present, including the bride-to-be, are urged not to sleep until at least 24.00 WIB during this occasion. The groom-to-be could not see the bride on this midodareni night. This midodareni is an important part of the marriage ceremony process. A unit of time connects Midodareni night, also known as tirakatan night, to mathematics. On Midodareni night, most people play a domino game that teaches probability.

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8. The bridal meeting ceremony or the panggih ceremony

It marks the conclusion of numerous traditional Javanese wedding rituals. There are numerous parties involved in this event, and many invited visitors show up. The entire series of ceremonies, notably the panggih ritual, must be flawlessly executed because it will be watched by a large number of invited guests.The relationship of the Panggih ceremony to mathematics is found in the opportunity material. Where at the Panggih ceremony is attended by many invited guests who can fit a room. So that when the invited guests are present, it is seen how many opportunities can enter the room.

9. Ritual ceremony "ngindak tigan"

The male substitute will walk on the native chicken eggs that are typically used in tigan, or eggs, which are laid out on trays. The groom's right foot stepped on the egg, breaking it. In addition, the bride is prepared to wash the groom's feet with wijik sekar setaman, a floral water. The bride then performs sungkem as a symbol of a wife's devotion to her husband after drying the groom's feet and placing them in the bride's shoes. The ngindak tigan ceremony has two distinct meanings. First of all, it represents the change from being single for both brides to entering the difficult and demanding world of a new existence. Secondly, the breakdown of the bride's blood in this ritual has philosophical significance.

The ceremonial relationship of ritual events (ngindak tigan) is in the power material, the mass that must be used to be able to break and also the elliptical material. Where the egg is stepped on by the groom with strong pressure and the oval-shaped egg.

Conclusion

After exploring the javanese cultural marriage tradition, it can be concluded that there are several mathematical aspects in the Javanese cultural marriage tradition that have been carried out so far. In the early stages of watching it contains mathematical aspects in the form of the concept of building space. In addition, there is also the concept of number operations, namely the addition of the weton and Siraman petung (calculation) stages. Geometric elements such as building flats and building spaces on tools used in the tradition of installing tarubs, flushing, twins and on items

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carried during handovers. At tirakatan events or midodareni nights and panggih ceremonies here there is a concept of opportunity.

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Mathematical literacy: a bibliometric analysis

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Abstract. *This study aims to determine the map of the development of research on the topic of Mathematic Literacy using VOSviewer. The study is began with a search for several articles on the www.Tandfonline.com which the access were opened on October 3, 2022 using the keywords "Mathematical Literacy" or "Mathematics Literacy". The result obtained 30383 documents from 1078 databases. But only 70 documents that fit the criteria and could be used from 32 scopus indexed journals. Then the article is stored in the form of Research Informatic Sytem (RIS) and analyzed using VOSviewer using the author keyword. The journal that publishes the most on mathematical literacy is the African Journal of Research in Mathematics, Science and Technology with 11 documents, followed by the International Journal of Mathematical Education in Science and Technology with 9 documents. The analysis results show that the topic which most often discussed with Mathematical Literacy is PISA followed by the Mathematics Education topic. The visualization between topics is connected by lines connector. The larger the topics, the more often the topic is researched and vice versa. The more often these topics are connected by the lines connector, the stonger the closeness between these topics. In overlay visualization green color shows the topics that have been researched for a long time, while yellow color represents current topics. Meanwhile, density visualization shows that the yellow topics are trending topics. For future researchers, this mapping provides information about space that has not been discussed together with the topic of Mathematical Literacy*

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Keywords: mathematical literacy; Bibliometric; VOSviewer; analysis; scopus

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Introduction

Mathematical literacy is a lifelong skill that humans must have in order to survive and having sensitivity to various complex life issues and require solutions. These competencies are needed to meet the demands of life in modern society [1], was expressed through the use and engagement with mathematics, making decisions and understanding the usefulness of mathematics needed in life [2]. Mathematical literacy involves more than problem solving procedures [3]. The urgency of this topic becomes very important because it was seen as a suitable, vital, and flexible ability in the 21st century.

Various studies were carried out to measure, further examine related topics and until now mathematical literacy is still a trending topic, because it was used as a guide to measure students' abilities at the international level, namely PISA and TIMSS. However, results of the study certainly contains shortcomings in terms of various perspectives. To help researchers get an overall picture of mathematical literacy research, especially for beginners, it is necessary to do a bibliometric mapping analysis.

Bibliometric analysis performs a systematic review, exploration and trend of a topic in a number of articles. Bibliometric analysis examines in detail the main research topics using author keywords [4], this analysis manages information in certain fields by reviewing bibliography objectively and quantitatively [5] so easy to get information as a whole in an organized manner. One of the ways to do bibliometric analysis is by using the VOSviewer application, which is a software to construct and visualize a comprehensive bibliometric network [6].

Based on the explanation above, this study focuses on bibliometric analysis with VOSviewer a number of quality articles indexed by Scopus so it provide an overview of the most frequently topics, which are still rarely discussed together with mathematical literacy topics, trending topics, researchers who often write about mathematical literacy topics, researchers who collaborated and the journal that most frequently publishes on the topic of mathematical literacy.

Methodology

This study uses a qualitative approach with bibliometric analysis. This analysis uses the application of statistical methods to qualitative and quantitative changes in a particular science research topic, establishes a profile of publications on that topic, and detects trends within a discipline [7]. The search was carried out on a number of articles in the scopus database and accessing the website address www.tandfonline.com by typing the keywords "mathematical literacy" and "mathematics literacy". Furthermore, the data is filtered according to the criteria, namely containing the word mathematical literacy in the title or discussing the word in the abstract and in the author keyword. Then, with these criteria, 70 documents were obtained from 32 scopus indexed databases. The document was repaired metadata in Mendeley and saved in the form of a Research Informatic System (RIS) and then analyzed using VOSviewer. VOSviewer allows the creation of term maps, which are two-dimensional maps where the frequency of occurrence of a particular term is determined by the size of the distance label between the two terms, this indicates the relationship between the terms, based on the number of occurrence in the corpus file with co-occurrence based on the author keyword [8].

VOSviewer also provides a list of word sets that can be considered so that they are closely related to each other, and identify them with the same color set in the term map [8].Here we provide some basic advice for formatting your mathematics, but we do not attempt to define detailed styles

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or specifications for mathematical type setting. You should use the standard styles, symbols, and conventions for the field or discipline you are writing about.

Result and discussion

Mapping of mathematical literacy research was carried out to examine the topics that had been discussed together with these topics. The results of the study on mapping will provide an overview of the most frequently discussed topics, which are still rarely discussed and topics that still have the opportunity to be discussed together with mathematical literacy. The mapping results can also show the authors who write the most on mathematical literacy and the journals that publish the most articles on mathematical literacy. To answer this, a search was carried out on the page www.tandfonline.com, which is a database of articles indexed by Scopus. The search was conducted on October 3, 2022. The search results obtained 30383 documents from 1078 databases. The data is filtered according to the criteria, namely containing the word mathematical literacy in the title or discussing the word in the abstract and in the author keyword. The results obtained 70 documents from 32 journals on the scopus database. The distribution of articles by year of publication is presented in Figure 1.

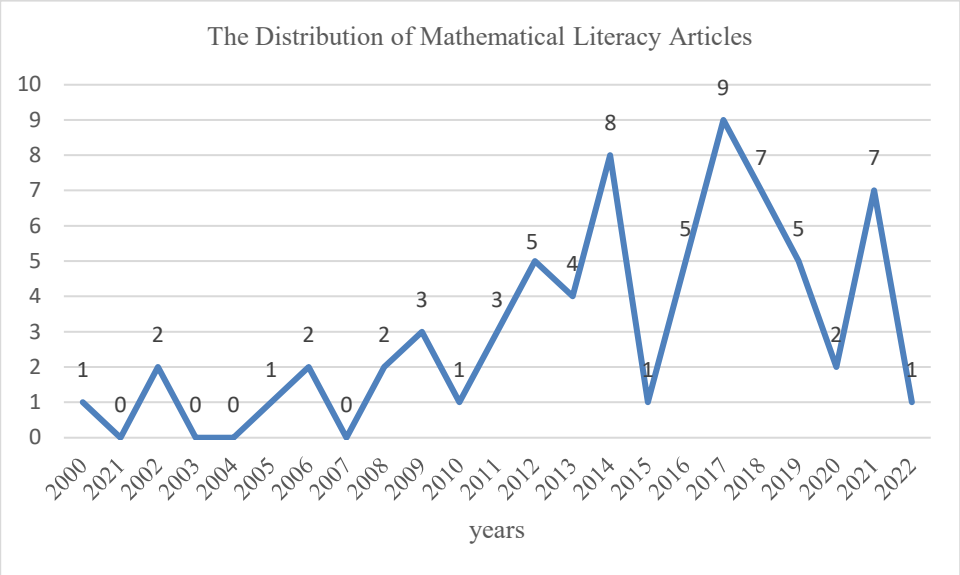


Figure 1. The distribution of mathematical literacy articles.

Figure 1 shows that the distribution of mathematical literacy articles published on the accessible Scopus database fluctuated from 2000 to 2022, some years did not even exist, namely 2001, 2003, 2004 and 2007 and the highest was 2017. By this datas averange obtained 3 articles per year or very small. The search results of 70 articles in the database show that the journals that most frequently publish articles on mathematical literacy are presented in Table 1.

Table 1 shows the 5 journals that publish the most mathematical literacy articles, namely the African Journal of Research in Mathematics Science and Technology which is the journal that publishes the most articles on mathematical literacy with 11 articles, followed by the International Journal of Mathematical Education in Science and Technology with 9 articles. , International Journal of Educational Sciences with 5 articles, Proceedia-Social and Behavioral Sciences with 4 articles and Journal of Educational Research with 3 articles. These results illustrate that the number

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of articles related to the topic of mathematical literacy published by Scopus indexed journals is still small in the period 2000 to 2022 and there are opportunities for an other researchers to publish articles in these journals.

Table 1. Most journals publish mathematical literacy articles

No.	Journal	The number of articles
1	African Journal of Research in Mathematics Science and Technology	11
2	International Journal of Mathematical Education in Science and Technology	9
3	International Journal of Educational Sciences	5
4	Proceedia-Social and Behavioral Sciences	4
5	Journal of Educational Research	3

Furthermore, from the 70 articles filtered based on the criteria containing the word mathematical literacy in the title or discussing the word in the abstract and the author keyword, the metadata was corrected in the form of article title, author, year of publication, journal publication, abstract and author keywords in Mendeley and stored in Research Informatic Systems (RIS). RIS data will be extracted bibliometrically by using VOSviewer using the co-occurance analysis type for keyword analysis unit, co-authorship for author analysis unit and full counting method. Author keyword analysis with full counting method is shown in Figure 2.

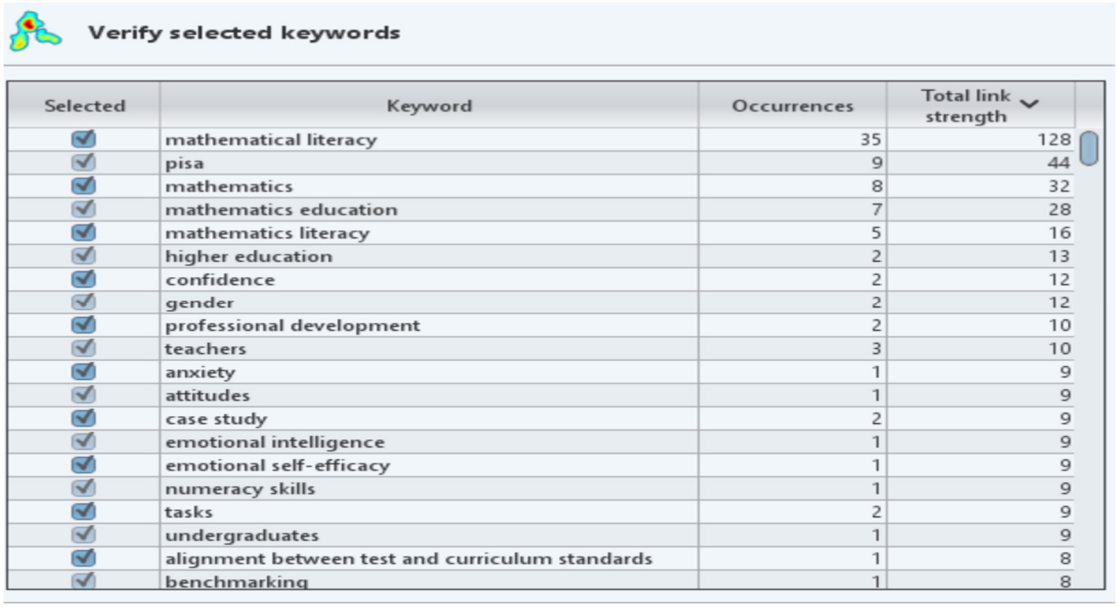


Figure 2. Results of keyword extraction with full counting method

From 238 available author keywords with a minimum of 1 co-occurrence, 238 author keywords are obtained that meet the requirements. Figure 2 shows that the highest occurrences are on the topic of mathematical literacy, which is 35 times with a total link strength of 128, followed by PISA 9 times with a total link strength of 44, mathematics 8 times with a total link strength of 32, mathematics education 7 times with a total link strength 28, mathematics literacy 5 times with

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a total link strength of 16. The visualization display based on occurrences and link strength is shown in Figure 3 below.

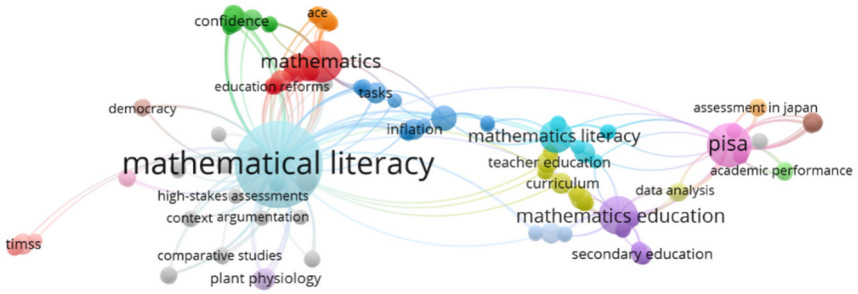


Figure 3. Display Visualization

The Display Visualization in Figure 3 shows the topic map in several different colors. The color difference is determined by the close relationship between the topics. Between topics are connected by connector lines to form 32 clusters indicated by 32 different colors, some of which are yellow, red, green, orange, purple. Mathematical literacy topics that have the most occurrences and link strength are visualized with the largest size, while those with the fewest occurrences are shown with the smallest size. The higher the link strength, the more connector lines connected to the topic, indicating the closeness of a topic to form a cluster.

The topic of mathematical literacy is the topic that is most often discussed and is connected 35 times with the other topics, followed by the topics of PISA [9–13], mathematics [14–16] and mathematics education [17–19]. Other topics related to mathematical literacy with a small size include assessment in Japan [10], inflation [20, 21], secondary education [22, 23], TIMSS [24, 25], tasks [26], case study [27, 28], content area literacy [28], higher education, confidence [29, 30], South Africa [31], mathematical modelling [32, 33]. Topics with a small size indicate that the topic is still rarely studied. Meanwhile, topics that do not appear on the map can be used as further studies.

This mapping provides an overview of several topics that are often and still rarely discussed together with mathematical literacy so as to provide opportunities for other researchers to study more deeply. This analysis produces information that is very useful for researchers to evaluate scientific activities [34], thus being able to consider and make decisions on the studies to be carried out. While the density visualization is presented in Figure 4.

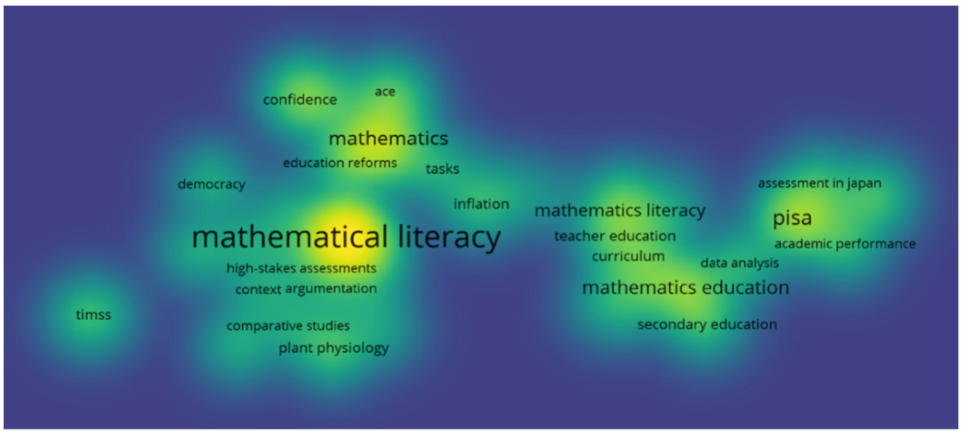


Figure 4. Density Visualization

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Figure 4. shows that the yellow color is a trending topic, while the dark color is a topic that has been researched for a long time. Visualization shows that mathematical literacy is still a topic often discussed today. This is very possible, because mathematical literacy is one of the global assessment standards at the international level by PISA to measure students' abilities. This assessment standard aims to prepare students for the challenges of their lives in the future. Assessment results are used to provide an overview of student performance from various countries, track changes in performance over time and relate features of the student learning environment to performance [35]. Through VOSviewer, it is also possible to map the authors who most often write mathematical literacy articles. Map visualization can be seen in Figure 5.

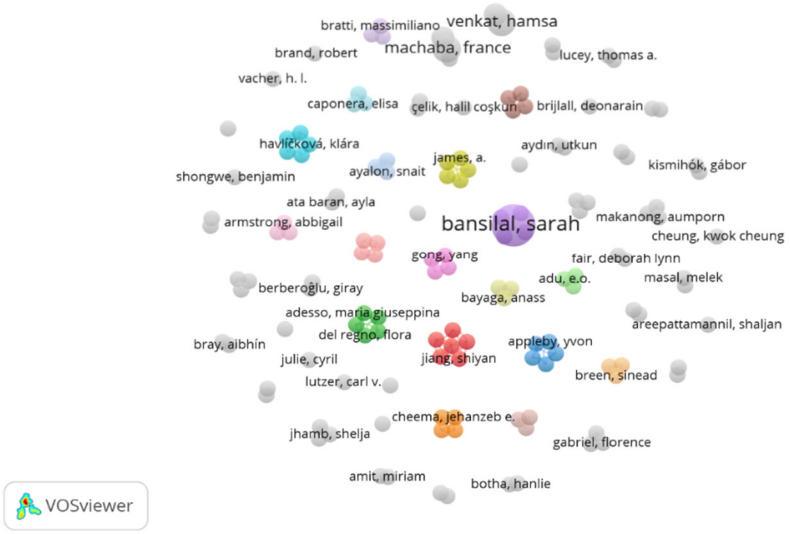


Figure 5. Display Visualization of The Authors

Based on the mapping in Figure 5 presented by VOSviewer, it can be seen that Sarah Bansilal, Hamsa Venkat, France Machaba, Willy Mwakapenda and Mellony Graven are the researchers who most often write mathematical literacy articles indicated by large circles. Even between Mellony Graven and Hamsa Venkat, France Machaba and Willy Mwakapenda have collaborated to write together twice. The small circle in one color shows the authors who have written together, some of which are studies on horizontal mathematization which between context presentation and model formulation for teachers [33], integrating the concept of critical mathematics education with intersectional feminism. to revise the PISA mathematical literacy framework as an international guide [36] on the VOSviewer map shown in red with Jiang Shian as one of the authors and a comparison of the visual spatial abilities of prospective secondary school teachers in North Africa [37].

Conclusion

Bibliometric analysis with VOSviewer provides an overview of the number of mathematical literacy articles from 2000 to 2022 in the Scopus data base. The analysis shows that the destination journals on scopus publish the most mathematical literacy articles, the topics that are most frequently discussed, are still rarely discussed together with the topic of mathematical literacy. The results of the analysis have also informed writers who often write and or collaborate with other

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authors on the topic of mathematical literacy. This bibliometric analysis with VOSviewer is expected to provide insight and an overview of other studies that will be carried out related to the topic of mathematical literacy.

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Validation of teaching material of variance analysis aided by R software

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Abstract. *This article was created based on the results of research into the construction of teaching materials for variance analysis aided by R software. The principle is to integrate R statistical software in the study of variance analysis with the aim of producing valid teaching material on variance analysis. This research is research and development through four stages, namely analysis, planning, development, evaluation and revision. The instrument used is in the form of a validation sheet by an expert which includes four aspects assessment are : format, language, illustrations and content Based on validation by two experts for two revisions, it was determined that the teaching material for the analysis of variance was valid with a validation value of 4.06.*
Keywords: Analysis of variance, teaching material, validity, R software

Introduction

Based on the description of the undergraduate qualification level in mathematics education contained in the curriculum based on the Kerangka Kualifikasi Nasional Indonesia (KKNI), there are three main competencies that must be mastered by students, namely the ability to apply concepts in mathematics science, the ability to use science and technology for life skills, and the ability to conduct a simple research in mathematics education [2]. Research development is a process or steps to develop a new product that enhances an existing product which can be accounted [6]. Teaching materials are one of a set of learning tools and become a supporting factor in the success of a learning process, because teaching materials are a collection of teaching materials that are systematically arranged as tools for carrying out learning activities [4]. In the study of variance analysis, it is very susceptible to errors because the statistical calculations involved a lot of numbers, meanwhile R is a general purpose statistical software package used in many fields of research [1], therefore in this reseach will be constructed the teaching materials of variance analysis Aided by R Software.

Methodology

The material in this research is teaching material for analysis of variance assisted by R software which consists of one-way anova, Scheffe method, homoscedasticity and two-way anova. The

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teaching materials constructed are in the form of handouts with five main components, namely titles, lecture objectives, material summaries, practice questions and references. The method used is a research and development method: research that produces a product, which is teaching materials for analysis of variance assisted by R software, which is valid. In [5], the Plomp model is based on five phases: the initial investigation phase, the design phase, the realization or construction phase, the trial phase, evaluation and revision, and the implementation phase. The instrument for testing the validity of teaching materials is a validation sheet, which consists of four validation aspects that have been modified from [3], including format, language, illustration, and content. This validation process is carried out by two experts on the indicators contained in each aspect, as shown in Table 1 below:

Table 1. Validation format of teaching material

Aspect (A)	**Indicator (I)**	**Validator**		**Average each (I)**	**Average each (A)**	**Total average (Va)**
		1	2			
Format						
Language						
Illustration						
Contents						
Average						

Assessment of the validity of each aspect of teaching materials through each indicator uses a scale of 1-5, while the criteria for the validity of teaching materials are guided by Table 2 below:

Table 2. Criteria for the validity of teaching material

No.	**Total average of Va**	**Criteria of validity**
1	$1 \leq Va < 2$	Invalid
2	$2 \leq Va < 3$	not valid
3	$3 \leq Va < 4$	quite valid
4	$4 \leq Va < 5$	Valid
5	$Va = 5$	very valid

Results and discussion

Based on validation by two teaching material experts, the initial validation results are still not valid with a value of Va = 3.64, making it necessary to improve the format and language aspects. The format aspects include the numbering system, layout settings, and font sizes, while the linguistic aspects include the use of terms, the use of sentence structure, the location of paragraphs, and the nature of language communication. Therefore, the first revision was carried out. Based on the validation in the first revision, it was found that the results were not valid with a value of Va = 3.96, so improvements were made to the linguistic aspects which included the use of terms and the location of paragraphs, so a second revision was needed. Based on the validation of the second revision, it was found that the teaching material for analysis of variance assisted by software R had fulfilled the valid criteria with a value of Va = 4.06.

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Conclusion

The teaching material for analysis of variance assisted by R software made in this study was in the form of a handout with five main components: the title, lecture objectives, material summary, practice questions, and references. Aspects validated by two experts include format, language, illustration, and content. The assessment of the validity of each aspect of teaching materials through each indicator uses a scale of 1–5, while the criteria for the validity of teaching materials are invalid, invalid, moderately valid, valid, and very valid. The making of teaching materials for analysis of variance assisted by R software is valid after three validations by experts and two revisions by researchers.

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Learning mathematics using autograph for review based on students' mathematic communication ability

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Abstract. *When it comes to math, students' ability to communicate their ideas in a clear and concise manner is significantly higher when they use the autograph-assisted discovery learning model than when they use traditional methods. Quasi-Experimental Research was used in this study, which involved all students in MAN Asahan's class XI. Random sampling and selective sampling are used to select class samples. Students' mathematical communication abilities are assessed through the use of this instrument. Parametric statistical analysis was used to examine the study's data. T-test analysis was used to conduct statistical analysis of the data. Students' mathematical communication skills using the autograph-assisted discovery learning model were higher than students' mathematical communication skills using conventional learning, according to the findings. Students in class XI IPA-1 who were taught Geometry Transformation using the discovery learning model had an average communication skill score of 79.56. Students in class XI IPA-2 who are being taught with traditional methods on Geometry Transformation material have an average mathematical communication ability of 70.98.*

Keywords: autographs, mathematical communication ability

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Introduction

Education is an important component in country formation. National human and community development goals include education. The quality of a country's education influences its progress. A nation cannot change or advance without education. Education is directly linked to schooling. Learning is an important part of schooling. School-based learning consists of numerous sciences grouped into subjects. Mathematics is an important topic to learn in school. Education is critical to improving human resources. So, to educate the nation's life, education must develop talents and mold the character and civilisation of a dignified nation.

Mathematics is one of the courses taught from kindergarten through university. Because mathematics is crucial in many aspects of life, notably enhancing the strength of human mind, it is required at every school level from kindergarten to high school. Mathematics can help students understand and solve difficulties connected to mathematical concepts they encounter in everyday life. A mathematical difficulty is a mathematical problem that cannot be solved rapidly. But not all math problems are student issues. A math problem is a math problem if the learner is willing to solve it but lacks an idea. The question is not an issue for kids if they have an idea to answer it. As a result, the mathematics issues that pupils face vary from person to person. While each student has unique mathematical issues, all students have challenges in learning mathematics. Mathematics is a universal science that enhances human thinking power and underpins modern technology development [1]. Mathematics is a lesson that is taught to students from elementary school to university. It is used as a science to measure and compute a building. tall. So mathematics is crucial in precision science and technology.

Identify, understand, and apply mathematical concepts, procedures, principles, and ideas; solve mathematical problems (mathematical connection); reason mathematically (mathematical connection); and communicate mathematically (mathematical communication) (mathematical communication) [2]. According to NCTM (2000) students must be able to communicate mathematically, reason mathematically, solve mathematical problems, link mathematically, and depict mathematically. Thus, mathematical reasoning ability is one of the talents expected to emerge as a result of learning mathematics and play a crucial role in obtaining optimal mathematics learning outcomes [3].

Communication is one of the NCTM's standard processes that students must understand to study mathematics. Students must clearly master mathematical communication skills. It is the way pupils integrate mathematical ideas (pictures, graphs, symbolic) logically [4]. So teaching pupils mathematical communication should be a priority. [3] the capacity to solve problems mathematically using drawings, symbols, diagrams, and graphs; and [4] the ability to communicate concepts orally or in writing. Students can use mathematical communication to communicate problem-solving ideas, strategies, and solutions orally and in writin [5]. Mathematical communication is the capacity to explain mathematical ideas and arguments clearly and concisely. Thus, mathematical communication abilities are an important talent to develop in mathematics education [6]. Mathematical communication abilities include the capacity to express mathematical ideas vocally and in writing, as well as to understand and accept others' mathematical ideas orally and in writing. [7] The results demonstrated that Indonesian students still lacked mathematics communication skills. Multiple studies reveal that many Indonesian students lack mathematics communication skills. Kaselin et al. found that only 6–8 students out of 4 study groups of 30 have good mathematics communication skills. Many students still struggle to apply knowledge, utilise data/information, and relate problems to real-life situations [8]. Thereby showing great outcomes

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in answering problems utilizing story questions and markers of mathematics communication skills [9]. Notes students' poor communication abilities due to a lack of concentration in mathematics instruction [10]. For example, Kadir [11] discovered that coastal junior high students lack mathematics communication abilities. Mathematical communication abilities were low in junior high students (particularly in rural areas), according to Qohar [12]

The key reason why students' mathematics communication abilities were not optimized was the traditional learning procedure. Mathematical education needs an upgrade, say researchers. To increase students' mathematical communication skills, the renewal in learning involves using learning models that can pique students' interest in mathematics and foster critical thinking. Teachers must be smart in selecting and executing models so that pupils do not get tired learning mathematics [13]. The Discovery Learning methodology can be used to improve students' mathematics communication skills. The Discovery Learning methodology allows children to study independently and actively so they can discover new concepts, relationships, and meanings. Discovering information, comparing and organising resources are all part of the Discovery Learning approach [14]. Human-led discovery activities yield the best outcomes and are more meaningful for humans [15]. Technology and education are inextricably linked. According to Diana [16], education is a process that helps people develop their potential and raise their dignity so they can confront any changes that come their way. One of them is mathematics. So learning mathematics is vital. Because it is intertwined with everyday problems involving calculations.

The evolution of education in 2013 is inextricably linked to technological advancement. Growing rapidly in the age of globalization is information and communication technology (ICT). One of these is computers. The use of computers is widespread in science and education. It is incredibly useful for both teachers and students in education. Computers help students understand mathematics, especially unusual math problems that are related to everyday life. Students will be more motivated to learn mathematics if they can solve mathematical problems using computer software. The Autograph Software, according to Karnasih [17] can be used to learn about two-dimensional and three-dimensional math. Autograph will assist students with new research. Students can test more examples than utilizing formulae, allowing them to discover, create, and conclude mathematical concepts, and ultimately understand mathematical talents. Based on the previous description, it appears that the discovery learning paradigm with Autograph can improve students' mathematical communication skills. However, there is no research on the Autograph-assisted discovery learning paradigm, which is utilized as an alternative in Geometry Transformation learning. In order to assess students' mathematical communication skills, researchers will use the Autograph-assisted discovery learning paradigm.

Methodology

This research used a pretest-posttest only group design. The study population consisted of 288 students from class XI MAN Asahan in the even semester of 2021/2022. The sample in this study was students from class XI IPA-1 AND X IPA-2 MAN Asahan. This study has two variables: independent and dependent. The dependent variable is students' mathematical communication skills, while the independent variable is the Discovery Learning learning paradigm.

This study employed a pretest-posttest only group design. With the help of Geogebra software, the outcomes of the pretest and posttest were compared. Table 1. shows the pretest-posttest only group design.

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Table 1. One-Group Pretest-Posttest Design

Pre Test	Treatment	PostTest
O_1	X	O_2
O_1	Y	O_2

This study's tool was a test of students' mathematical communication skills. This student's math communication test is a written description. This test measures students' mathematical communication skills in addressing problems.

Data processing

To collect data from students' mathematical communication skills, the research class is given a pretest. Then the research class received a discovery learning model with software autograph treatment. A posttest is administered at the end of class. Also, before testing for significance, the data must first pass a normality and homogeneity test. The t-test was also employed to assess the hypothesis for students' mathematical literacy skills. The ultimate conclusion can be taken from the statistical tests performed by comparing the levels of significance to accept or reject the researcher's hypothesis.

Results and discussion

Results of Research Experiment and Control Classes

Both samples were pre-tested before learning activities. Pre-testing pupils' mathematics communication skills before using exploration and traditional learning methodologies. The test is an essay test with ten questions. Table 2 shows the pre-test scores for the experimental and control classes.

Table 2. Experimental and Control Class Pre-test scores

Data_Pretest

Class	Mean	Variance	Std. Deviation	Maximum	Minimum
Eksperimental	55,7209	140,587	11,85694	75,00	30,00
Control	45,0465	132,569	11,51387	70,00	30,00
Total	50,3837	163,792	12,79813	75,00	30,00

Table 2 The pre-test data show a comparison of values between the experimental and control classes. The experimental class average was 55.72, with a variance of 140.59, a standard deviation of 11.86, and a range of 75 to 30. The control class average was 45.05, with a variance of 132.57, standard deviation 11.51, and a range of 70 to 30. Then comes the analytical requirements test. Requirements The Normality and Homogeneity Tests of Variance are utilized.

a. Normality test

The normality test determines if the data from each class is regularly distributed, both discovery and conventional learning classes. Using the Lilliefors test with n = 43 and significance = 0.05 to test for normality.

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Based on SPSS data analysis, Statistics 22 obtained the following data:

Table 3. Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Kelas	Statistic	Df	Sig.	Statistic	Df	Sig.
Data_Pretest	Eksperimen	,104	43	,200*	,962	43	,167
	Kontrol	,106	43	,200*	,920	43	,005

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Table 3 shows that for the experimental class Lcount = 0.104, significant value = 0.200, n = 43, and 0.05, Ltable = 0.1351 is calculated using SPSS Statistics 22. Due to Lcount = 0.104 Ltable = 0.1351 and significance = 0.200 > 0.05, Ho is accepted. In the control class, Lcount = 0.106, significant = 0.200, n = 43, 0.05, Ltable = 0.1351 Given that Lcount>Ltable and significance > 0.05, Ho is accepted as the sample is from a normally distributed population.

b. Homogeneity Test

The homogeneity test checks whether the variables are the same[18]. The F test checks for homogeneity of sample variance. F table = 1.68 at significance = 0.05 and dk = v 1 = n-1 = 43-1 = 42. The table below shows the results of calculating the homogeneity of variance of the pre-test data:

Table 4. Test of Homogeneity of Variances

Data_Pretest

Levene Statistic	df1	df2	Sig.
,089	1	84	,766

In Table 4, SPSS Statistics 22 calculates sig. > = 0.05. If Fcount>Ftable, then sig = 0.766 shows that sig > 0.05. In conclusion, both experimental and control sample groups' pretest data variances came from a homogeneous population.

Results of Research Experiment and Control Classes

The post-test assessed the students' mathematics communication skills following both models. The test is an essay with ten questions. The following data were acquired via post-test data analysis using SPSS Statistics:

Table 5. Experimental and Control Class Post-test scores

Data_Postest

Kelas	Mean	Variance	Std. Deviation	Maximum	Minimum
Eksperimen	79,5581	176,252	13,27601	100,00	50,00
Kontrol	70,9767	136,642	11,68941	95,00	50,00
Total	75,2674	173,234	13,16182	100,00	50,00

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Table 5 The post-test data show a score comparison between the experimental and control classes. The experimental class average is 79.56, with a variance of 176.252, a standard deviation of 13.28, and a range of 100 to 50. The control class average is 70.98, with a variance of 136.642, a standard deviation of 11.69, and a range of 95 to 50.

Post-test data were subjected to the same requirements analysis tests as pre-test data, namely normality and homogeneity. Post-test results were normal and homogeneous before testing the hypothesis.

a. Normality Test

Using the Lilliefors test with n = 43 and 0.05 for normality of post-test data. Based on SPSS data analysis, Statistics 22 obtained the following data:

Table 6. Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Class	Statistic	df	Sig.	Statistic	df	Sig.
Data_Postest	Eksperimental	,133	43	,054	,947	43	,045
	Control	,263	43	,000	,919	43	,005

a. Lilliefors Significance Correction

The experimental class obtained L count = 0.133 with a significant value = 0.054 and with n = 43 and = 0.05 produced Ltable = 0.1351. Because Lcount>Ltable and significance > 0.054, Ho is accepted, indicating that the sample is normally distributed. Using n = 43 and 0.05, Ltable = 0.1351 was achieved in the control class. Because Lcount = 0.263 >Ltable = 0.1351 and significance = 0.000 0.05, Ho is accepted.

b. Homogeneity Test

The F test for homogeneity of sample variance (Test the Similarity of Two Variances). F table = 1.68 at significance = 0.05 and dk = v 2 = n-1 = 43-1 = 42. The table below shows the results of calculating the post-test data homogeneity of variance:

Table 7. Test of Homogeneity of Variances

Data_Postest

Levene Statistic	df1	df2	Sig.
1,046	1	84	,309

In Table 7, SPSS Statistics 22 calculates sig. > = 0.05. If Fcount>Ftable, then sig = 0.309 shows that sig > 0.05. Thus, the variance of the post-test data from the two sample groups, experimental and control, came from a homogeneous population.

Stats Meta-Analysis

Hypothesis testing was carried out using t-test through the average equation of the test of two parties, namely the right side, thus the statistical hypothesis was:

$H_0 : \mu_1 = \mu_2$Students who use the autograph-assisted discovery learning model have the same level of mathematical communication ability as students who use standard learning methods.

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$H_a : \mu_1 > \mu_2$:Students who use the autograph-assisted discovery learning model have higher mathematics communication abilities than students who use conventional learning methods.

Table 8. Group Statistics

	Kelas	N	Mean	Std. Deviation	Std. Error Mean
Data_Postest	Eksperimen	43	79,5581	13,27601	2,02457
	Kontrol	43	70,9767	11,68941	1,78262

Table 9. Independent Samples Test

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
VAR00001	Equal variances assumed	1,046	,309	3,181	84	,002	8,58140	2,69752	3,21708	13,94571
	Equal variances not assumed			3,181	82,675	,002	8,58140	2,69752	3,21582	13,94697

To test the hypothesis, the data from both classes must be normally distributed and homogeneous. In this study, hypotheses were tested to see if they were true. This was tested using the T-test. The post-test data analysis revealed t Calculate=3.18 with n 1=n 2=43. t ((0.95)(84))=1.66 when significant level =0.05 and degrees of freedom (db)=43+43-2=84.

To conclude, students' mathematical communication skills have a greater impact on statistical material using the discovery learning model than students' mathematical communication skills using conventional learning models in class XI MAN Asahan.

Conclusion

Based on research results from class XI MAN Asahan for the academic year 2021/2022, the following conclusions can be drawn:

1. The mathematics communication skills of students in class XI IPA-1 who were taught Geometry Transformation using the discovery learning paradigm averaged 79.56.
2. The mathematics communication ability of pupils taught using normal learning methods in class XI IPA-2 is 70.98.
3. Students' mathematical communication skills are higher in Geometry Transformation material using the discovery learning model than in class XI MAN Asahan.

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Stability analysis of modified SEIQR on dynamics of SARS-CoV-2 with control on vaccination, quarantine and international in-out mobility in Indonesia

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Abstract. *SARS-CoV-2 (Severe Acute Respiratory Syndrome Coronavirus 2) is a virus that attacks the respiratory system causing a respiratory syndrome known as Covid-19 (Coronavirus Disease 2019). This virus was first identified in Wuhan in December 2019 and has spread worldwide to become a pandemic. The Indonesian government has made various efforts to deal with the spread of Covid-19 in Indonesia, such as Imposing Restrictions on Community Activities (PPKM), carrying out vaccinations, and quarantining infected individuals. This study aims to analyze the stability of the modified SEIQR model for the spread of Covid-19 in Indonesia. This modified model considers international in-out mobility and quarantine efforts for exposed, infected individuals and international travelers entering Indonesia. This model has two critical points that are asymptotically stable, namely the virus-free critical point and the endemic critical point. We have carried out a simulation using the fourth-order Runge-Kutta Method in Matlab using Covid-19 data (March 2020-August 2022).*

Keywords : dynamic system, stability, SEIQR model, SARS-CoV-2

Introduction

The coronavirus or SARS-CoV-2 (Severe Acute Respiratory Syndrome Coronavirus 2) is a virus that attacks the respiratory tract and causes a disease called Covid-19 (Coronavirus Disease 2019). The first infection with Covid-19 in humans occured in Wuhan, Hubei, China in December. 2019 In mid-December 2019, the Covid-19 outbreak began to spread around the world, and then in

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March 2020, it was announced as a global health emergency or pandemic by the World Health Organization [1].

Indonesia is one of the countries affected by the Covid-19 pandemic. The government has imposed a number of activity restrictions to avoid direct contact between people and suppress the surge in Covid-19 cases in Indonesia. On April 17, 2020, Large-Scale Social Restrictions (PSBB) were imposed, followed by the Enforcement of Restrictions on Community Activities (PPKM) on January 11, 2021. Initially, PPKM was applied in Jakarta and 23 regencies/cities in six provinces which included in high-risk areas, and expanded to 15 regions outside Java and Bali. In addition, the Indonesian government has also imposed restrictions on international travel through various forms of government regulations regarding overseas travel during the Covid-19 pandemic [2].

Researchers from various fields are trying to make their contribution to overcoming the Covid-19 pandemic. Mathematical scientists are trying to predict the spread of the virus and build a model for it. Analysis of the mathematical model of Covid-19 has been carried out by [3-5] by considering the existence of isolation classes. The three studies show that the overall isolation of infected individuals can reduce the risk of spreading Covid-19. Another study by [6] analyzed the model using vaccination rate as the main parameter. The results of this study indicate that vaccination can effectively reduce the infected population but does not immediately end the pandemic. Further research regarding the mathematical model analysis of Covid-19 can be found in [7-9].

In 2021, Youssef et al developed a modification of the SEIQR model for the spread of Covid-19 using data in Saudi Arabia. The modified model follows the circumstances transmission of Covid-19 in Saudi Arabia. The results also show that the optimal effort to prevent the spread of Covid-19 is to limit social interactions and quarantine infected individuals and provide effective treatment of infected individuals and susceptible individuals.

The high rate of spread of Covid-19 in Indonesia requires more attention, so it is necessary to research this pandemic. This study analyzes the SEIQR model of the spread of SARS-CoV-2 by modifying the model proposed by [10] using spread data in Indonesia. The modification of the SEIQR model used will take into account the availability of vaccination, quarantine, and international in-out mobility in Indonesia.

Methodology

The object of this research is a modified Covid-19 dynamics model with scientific publications. The first step is to construct a modification scheme of SEIQR model for the spread of SARS-CoV-2, finding the critical point and type of stability based on the Routh-Hurwitz criteria. Numerical simulation of a model using Indonesian Ministry of Health data on the spread of Covid-19 in Indonesia.

Results and discussion

Modification of the SEIQR model for the spread of SARS-CoV-2

The spread of SARS-CoV-2 using the SEIQR model consists of five subpopulations, that are Susceptible (S), Exposed (E), Infected (I), Quarantined (Q), and Recovered (R). Model modification for the spread of SARS-CoV-2 was carried out based on research [10] which considers the control of vaccination, quarantine, and international in-out mobility. The modification scheme of the SEIQR model for the spread of SARS-CoV-2 is as follows:

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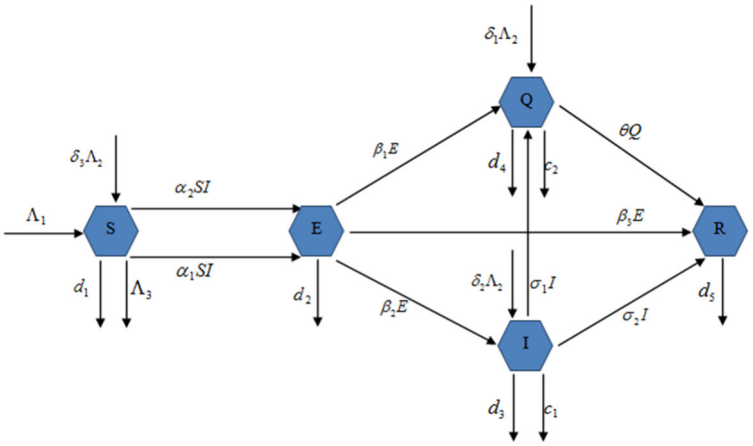


Figure 1. SEIQR model modification scheme

Based on the SEIQR model modification scheme above, a system of differential equations is acquired as follows:

$$\frac{dS}{dt} = \Lambda_1 + \delta_3\Lambda_2 - \Lambda_3 - (\alpha_1 + \alpha_2)SI - d_1 S$$

$$\frac{dE}{dt} = (\alpha_1 + \alpha_2)SI - (\beta_1 + \beta_2 + \beta_3 + d_2)E$$

$$\frac{dI}{dt} = \delta_2\Lambda_2 + \beta_2 E - (\sigma_1 + \sigma_2 + d_3 + c_1)I$$

$$\frac{dQ}{dt} = \delta_1\Lambda_2 + \beta_1 E + \sigma_1 I - (\theta + d_4 + c_2)Q$$

$$\frac{dR}{dt} = \beta_3 E + \sigma_2 I + \theta Q - d_5 R$$

Table 1. Variable definition

Variable	Description
S	The number of healthy individuals who are susceptible to infection
E	The number of individuals who tested positive for the virus during the incubation period but were unable to transmit it to others
I	The number of individuls who have tested positive for the virus and may transmit it to others
Q	The number of exposed and infected individuals who have been quarantined
R	The number of individuals who have recovered and are immune to the virus

Table 2. Parameter definition

Parameter	Description
d_1, d_2, d_3, d_4, d_5	Natural death rate of susceptible, exposed, infected, quarantined and recovered

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c_1, c_2	Death rate due to SARS-CoV-2 infection for subpopulation infected and quarantined
Λ_1	Susceptible addition parameter by birth
Λ_2	Susceptible addition parameter through in international mobility
Λ_3	Susceptible reduction parameter through out international mobility
α_1	Number of contacts susceptible to infection from local subjects
α_2	Number of contacts susceptible to infection from international subjects
β_1	Rate of exposed individuals who have quarantined
β_2	Rate of exposed individuals who have infected
β_3	Rate of exposed individuals who have recovered
σ_1	Rate of infected individuals who have quarantined
σ_2	Rate of infected individuals who have recovered
θ	Rate of quarantined individuals who have recovered
δ_1	Proportion of the number of infected individuals from in international mobility and quarantined
δ_2	Proportion of the number of infected individuals from in international mobility who are not quarantined
δ_3	Proporstion of increase in population suspect by mobility in international

Critical Points of SEIQR Model for the Spread of SARS-CoV-2

The points (S,E,I,Q,R) are the critical point when the system satisfies $\frac{dS}{dt}=\frac{dE}{dt}=\frac{dI}{dt}=\frac{dQ}{dt}=\frac{dR}{dt}=0$ [11]. The mathematical model of SARS-CoV-2 spread has two critical points: the disease-free critical point and the disease-endemic critical point. The model's critical point can be determined as follows:

$$\Lambda_1+\delta_3\Lambda_2-\Lambda_3-(\alpha_1+\alpha_2)SI-d_1S=0 \quad (1)$$

$$(\alpha_1+\alpha_2)SI-(\beta_1+\beta_2+\beta_3+d_2)E=0 \quad (2)$$

$$\delta_2\Lambda_2+\beta_2E-(\sigma_1+\sigma_2+d_3+c_1)I=0 \quad (3)$$

$$\delta_1\Lambda_2+\beta_1E+\sigma_1I-(\theta+d_4+c_2)Q=0 \quad (4)$$

$$\beta_3E+\sigma_2I+\theta Q-d_5R=0 \quad (5)$$

By solving the equation (1)-(5), the disease-free critical point obtained as follows:

$$E_0=(S_0^*,E_0^*,I_0^*,Q_0^*,R_0^*)=\left(\frac{\Lambda_1+\delta_3\Lambda_2-\Lambda_3}{d_1},0,0,\frac{\delta_1\Lambda_2}{\theta+d_4+c_2},\frac{\theta\delta_1\Lambda_2}{d_5(\theta+d_4+c_2)}\right)$$

where $\Lambda_1+\Lambda_2-\Lambda_3\geq 0$ and $0\leq\delta_2\leq 1$. And then, the disease-endemic critical point obtained as follows:

$$E_1=(S^*,E^*,I^*,Q^*,R^*)$$

with,

$$S^*=\frac{(\Lambda_1+\delta_3\Lambda_2-\Lambda_3)(\sigma_1+\sigma_2+d_3+c_1)}{(\alpha_1+\alpha_2)(\delta_2\Lambda_2+\beta_2E^*)+d_1(\sigma_1+\sigma_2+d_3+c_1)}$$

$$I^*=\frac{\delta_2\Lambda_2+\beta_2E^*}{\sigma_1+\sigma_2+d_3+c_1}$$

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$$Q^* = \frac{\delta_1 + \Lambda_2(\sigma_1 + \sigma_2 + d_3 + c_1) + \sigma_1\delta_2\Lambda_2}{(\theta + d_4 + c_2)(\sigma_1 + \sigma_2 + d_3 + c_1)} + \frac{\beta_1(\sigma_1 + \sigma_2 + d_3 + c_1) + \sigma_1\beta_2}{(\theta + d_4 + c_2)(\sigma_1 + \sigma_2 + d_3 + c_1)} E^*$$

$$R^* = \frac{\sigma_2\delta_2\Lambda_2(\theta + d_4 + c_2) + \theta\delta_1\Lambda_2(\sigma_1 + \sigma_2 + d_3 + c_1) + \theta\sigma_1\delta_2\Lambda_2}{d_5(\theta + d_4 + c_2)(\sigma_1 + \sigma_2 + d_3 + c_1)} + \frac{(\beta_3(\theta + d_4 + c_2) + \theta\beta_1)(\sigma_1 + \sigma_2 + d_3 + c_1) + \beta_2(\sigma_2(\theta + d_4 + c_2) + \theta\sigma_1)}{d_5(\theta + d_4 + c_2)(\sigma_1 + \sigma_2 + d_3 + c_1)} E^*$$

and

$$E^* = \frac{-B \pm \sqrt{D}}{2A} \text{ with } D = B^2 - 4AC > 0 \text{ and } -B \pm \sqrt{D} \geq 0$$

where

$$A = \beta_2(\alpha_1 + \alpha_2)(\beta_1 + \beta_2 + \beta_3 + d_2)$$

$$B = (\delta_2\Lambda_2(\alpha_1 + \alpha_2) + d_1(\sigma_1 + \sigma_2 + d_3 + c_1))(\beta_1 + \beta_2 + \beta_3 + d_1) - \beta_2(\alpha_1 + \alpha_2)(\Lambda_1 + \delta_3\Lambda_2 - \Lambda_3)$$

$$C = -\delta_2\Lambda_2(\alpha_1 + \alpha_2)(\Lambda_1 + \delta_3\Lambda_2 - \Lambda_3)$$

Linearization model and Jacobian matrix

Suppose the function is determined based on the SEIQR model as follows:

$$\begin{aligned} f_1(S,E,I,Q,R) &= \Lambda_1 + \delta_3\Lambda_2 - \Lambda_3 - (\alpha_1 + \alpha_2)SI - d_1S \\ f_2(S,E,I,Q,R) &= (\alpha_1 + \alpha_2)SI - (\beta_1 + \beta_2 + \beta_3 + d_2)E \\ f_3(S,E,I,Q,R) &= \delta_2\Lambda_2 + \beta_2E - (\sigma_1 + \sigma_2 + d_3 + c_1)I \\ f_4(S,E,I,Q,R) &= \delta_1\Lambda_2 + \beta_1E + \sigma_1I - (\theta + d_4 + c_2)Q \\ f_5(S,E,I,Q,R) &= \beta_3E + \sigma_2I + \theta Q - d_5R \end{aligned} \quad (6)$$

Based on equation (6), the Jacobian matrix is obtained as follows:

$$J = \begin{pmatrix} \frac{\partial f_1}{\partial S} & \frac{\partial f_1}{\partial E} & \frac{\partial f_1}{\partial I} & \frac{\partial f_1}{\partial Q} & \frac{\partial f_1}{\partial R} \\ \frac{\partial f_2}{\partial S} & \frac{\partial f_2}{\partial E} & \frac{\partial f_2}{\partial I} & \frac{\partial f_2}{\partial Q} & \frac{\partial f_2}{\partial R} \\ \frac{\partial f_3}{\partial S} & \frac{\partial f_3}{\partial E} & \frac{\partial f_3}{\partial I} & \frac{\partial f_3}{\partial Q} & \frac{\partial f_3}{\partial R} \\ \frac{\partial f_4}{\partial S} & \frac{\partial f_4}{\partial E} & \frac{\partial f_4}{\partial I} & \frac{\partial f_4}{\partial Q} & \frac{\partial f_4}{\partial R} \\ \frac{\partial f_5}{\partial S} & \frac{\partial f_5}{\partial E} & \frac{\partial f_5}{\partial I} & \frac{\partial f_5}{\partial Q} & \frac{\partial f_5}{\partial R} \end{pmatrix} \quad (7)$$

so that obtained

$$J = \begin{pmatrix} -(\alpha_1 + \alpha_2)I - d_1 & 0 & -(\alpha_1 + \alpha_2)S & 0 & 0 \\ (\alpha_1 + \alpha_2)I & -(\beta_1 + \beta_2 + \beta_3 + d_2) & (\alpha_1 + \alpha_2)s & 0 & 0 \\ 0 & \beta_2 & -(\sigma_1 + \sigma_2 + d_3 + c_1) & 0 & 0 \\ 0 & \beta_1 & \sigma_1 & -(\theta + d_4 + c_2) & 0 \\ 0 & \beta_3 & \sigma_2 & \theta & -d_5 \end{pmatrix} \quad (8)$$

Characteristic equation and type of stability

By substituting the value of E_0 into equation (8), we will get the Jacobian Matrix at the disease-free critical point, which is as follows:

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$$J(E_0)=\begin{pmatrix} -d_1 & 0 & -\frac{(\alpha_1+\alpha_2)(\Lambda_1+\delta_3\Lambda_2-\Lambda_3)}{d_1} & 0 & 0 \\ 0 & -(\beta_1+\beta_2+\beta_3+d_2) & \frac{(\alpha_1+\alpha_2)(\Lambda_1+\delta_3\Lambda_2-\Lambda_3)}{d_1} & 0 & 0 \\ 0 & \beta_2 & -(\sigma_1+\sigma_2+d_3+c_1) & 0 & 0 \\ 0 & \beta_1 & \sigma_1 & -(\theta+d_4+c_2) & 0 \\ 0 & \beta_3 & \sigma_2 & \theta & -d_5 \end{pmatrix} \quad (9)$$

The characteristic equation in the disease-free critical point is obtained if it satisfies

$$|\lambda I - J(E_0)| = 0$$

Thus, we can write the characteristic equation in disease-free critical point as follows:

$$(\lambda+d_1)(\lambda+d_5)(\lambda+\theta+d_4+c_2)r(\lambda)=0 \quad (10)$$

with $r(\lambda)=a_2\lambda^2+a_1\lambda+a_0$, where

$a_2=1$

$a_1=\beta_1+\beta_2+\beta_3+\sigma_1+\sigma_2+d_2+d_3+c_1$

$a_0=(\beta_1+\beta_2+\beta_3+d_2)(\sigma_1+\sigma_2+d_3+c_2)-\frac{\beta_2}{d_1}(\alpha_1+\alpha_2)(\Lambda_1+\delta_3\Lambda_2-\Lambda_3)$

Based on the Routh-Hurwitz Stability Criteria, it is found that the critical point is asymptotically stable if it was satisfied $d_1(\beta_1+\beta_2+\beta_3+d_2)(\sigma_1+\sigma_2+d_3+c_2)>\beta_2(\alpha_1+\alpha_2)(\Lambda_1+\delta_3\Lambda_2-\Lambda_3)$.

The Jacobian matrix at the disease-endemic critical point is obtained by substituing the values E_1 into equation (8), so that it is obtained:

$$\begin{pmatrix} -\frac{(\alpha_1+\alpha_2)(\delta_2\Lambda_2+\beta_2E^*)}{\sigma_1+\sigma_2+d_3+c_1}-d_1 & 0 & -\frac{(\alpha_1+\alpha_2)(\Lambda_1+\delta_3\Lambda_2-\Lambda_3)(\sigma_1+\sigma_2+d_3+c_1)}{(\alpha_1+\alpha_2)(\delta_2\Lambda_2+\beta_2E^*)+d_1(\sigma_1+\sigma_2+d_3+c_1)} & 0 & 0 \\ \frac{(\alpha_1+\alpha_2)(\delta_2\Lambda_2+\beta_2E^*)}{\sigma_1+\sigma_2+d_3+c_1} & -\beta_1-\beta_2-\beta_3-d_2 & \frac{(\alpha_1+\alpha_2)(\Lambda_1+\delta_3\Lambda_2-\Lambda_3)(\sigma_1+\sigma_2+d_3+c_1)}{(\alpha_1+\alpha_2)(\delta_2\Lambda_2+\beta_2E^*)+d_1(\sigma_1+\sigma_2+d_3+c_1)} & 0 & 0 \\ 0 & \beta_2 & -(\sigma_1+\sigma_2+d_3+c_1) & 0 & 0 \\ 0 & \beta_1 & \sigma_1 & -\theta-d_4-c_2 & 0 \\ 0 & \beta_3 & \sigma_2 & \theta & -d_5 \end{pmatrix} \quad (11)$$

The characteristic equation in the disease-endemic critical point is obtained if it satisfies

$$|\lambda I - J(E_1)| = 0$$

Thus, we can write the characteristic equation in disease-endemic critical point as follows:

$$(\lambda+d_5)(\lambda+\theta+d_4+c_2)s(\lambda)=0 \quad (12)$$

with $s(\lambda)=a_3\lambda^3+a_2\lambda^2+a_1\lambda+a_0$, where

$a_3=1$

$a_2=\beta_1+\beta_2+\beta_3+\sigma_1+\sigma_2+d_1+d_2+d_3+c_1+\frac{(\alpha_1+\alpha_2)(\delta_2\Lambda_2+\beta_2E^*)}{\sigma_1+\sigma_2+d_3+c_1}$

$a_1=(\beta_1+\beta_2+\beta_3+d_2)(\sigma_1+\sigma_2+d_3+c_1)+\frac{(\alpha_1+\alpha_2)(\delta_2\Lambda_2+\beta_2E^*)}{\sigma_1+\sigma_2+d_3+c_1}+d_1$

$-\frac{\beta_2(\alpha_1+\alpha_2)(\Lambda_1+\delta_3\Lambda_2-\Lambda_3)(\sigma_1+\sigma_2+d_3+c_1)}{(\alpha_1+\alpha_2)(\delta_2\Lambda_2+\beta_2E^*)+d_1(\sigma_1+\sigma_2+d_3+c_1)}$

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$$a_0 = (\alpha_1+\alpha_2)(\delta_2\Lambda_2+\beta_2E^*)(\beta_1+\beta_2+\beta_3+d_2)+d_1(\beta_1+\beta_2+\beta_3+d_2)(\sigma_1+\sigma_2+d_3+c_1) - \frac{d_1\beta_2(\alpha_1+\alpha_2)(\Lambda_1+\delta_3\Lambda_2-\Lambda_3)(\sigma_1+\sigma_2+d_3+c_1)}{(\alpha_1+\alpha_2)(\delta_2\Lambda_2+\beta_2E^*)+d_1(\sigma_1+\sigma_2+d_3+c_1)}$$

Based on the Routh-Hurwitz Stability Criteria, it is obtained that the critical point E_1 is stable if it satisfies $a_1>0$, $a_2>0$ and $a_1a_2>a_3a_0$.

Numerical simulation

The simulation of the model was carried out using the 4th Order Runge-Kutta Method and software MATLAB R2015a, using data on the spread of Covid-19 in Indonesia (March 2020-August 2022) by the Indonesian Ministry of Health [12]. The simulation period will be divided into two groups, namely the period before the vaccination (March 2020-December 2020) and the period after the vaccination (January 2021-August 2022).

Table 3. Parameter values

Before Vaccination			**After Vaccination**		
Parameter	**Value**	**Refference**	**Parameter**	**Nilai**	**Refference**
d_1	0.000001	Assumed	d_1	0.000001	Assumed
d_2	0.000001	Assumed	d_2	0.000001	Assumed
d_3	0.000001	Assumed	d_3	0.000001	Assumed
d_4	0.000001	Assumed	d_4	0.000001	Assumed
d_5	0.000001	Assumed	d_5	0.000001	Assumed
c_1	0.001009	Estimated	c_1	0.000059	Estimated
c_2	0.001009	Estimated	c_2	0.000059	Estimated
Λ_1	0.000001	Assumed	Λ_1	0.000001	Assumed
Λ_2	0.001849	Assumed	Λ_2	0.000646	Assumed
Λ_3	0.001849	Estimated	Λ_3	0.000646	Estimated
α_1	0.225244	Estimated	α_1	0.036061	Estimated
α_2	0.000918	Assumed	α_2	0.000918	Assumed
β_1	0.005027	Estimated	β_1	0.001000	Assumed
β_2	0.033939	Estimated	β_2	0.002015	Estimated
β_3	0.027928	Estimated	β_3	0.002088	Estimated
σ_1	0.005027	Estimated	σ_1	0.001000	Assumed
σ_2	0.027928	Estimated	σ_2	0.002088	Estimated
θ	0.027928	Estimated	θ	0.001849	Estimated

For the period before vaccination, numerical simulation of stability analysis were performed using initial value $S_0=6.777$, $E_0=0$, $I_0=1.528$, $Q_0=1.311$ and $R_0=0.081$. The parameter values based on data in Table 4 with $\delta_1=0$, $\delta_2=0.5$ and $\delta_3=0.5$ and the graph is shown in the following figure:

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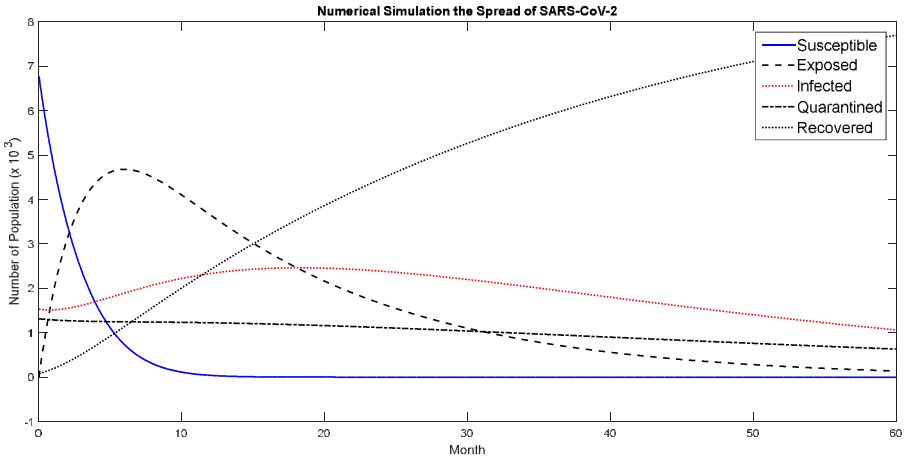


Figure 2. Stability of SEIQR model for the spread of SARS-CoV-2 before vaccinaton

The graph in Figure 2 shows that the numbers of individuals *S*, *E*, *I*, *Q*, and *R* are stable for the long term. The number of individuals in subpopulation *S* has been declining since the beginning of the simulation. This means that in group *S* the infectious process continues in the pre-vaccination period. The number of individuals in subpopulations *E* and *I* initially increased and then decreased. The number of individuals in subpopulation *Q* is slightly reduced. However, the number of individuals in subpopulation *R* continues to increase over time.

For the post-vaccination period, numerical simulation of stability analysis were performed using initial value $S_0 = 6.125290$, $E_0 = 0.073652$, $I_0 = 1.078314$, $Q_0 = 0.175095$ dan $R_0 = 0.873221$. The parameter values based on data in Table 4 with varying the value of parameter δ_1, δ_2, δ_3 and $\delta_1 + \delta_2 + \delta_3 = 1$. The first simulation will use the value of $\delta_1 = 0$, $\delta_2 = 0.5$ and $\delta_3 = 0.5$ in the following figure:

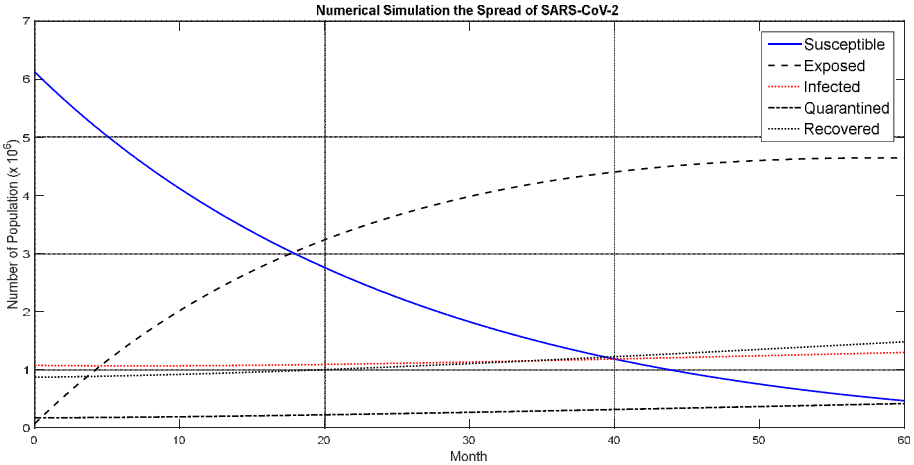


Figure 3. Stability of SEIQR model for the spread of SARS-CoV-2 after vaccinaton $(\delta_1 = 0, \delta_2 = 0.5, \delta_3 = 0.5)$

The graph in Figure 3 shows that the numbers of individuals *S*, *E*, *I*, *Q*, and *R* are also stable for the long term. The number of individuals in subpopulation *S* has been declining since the beginning of the simulation. This also implies that the infectious process for group *S* continues in the post-vaccination period. However, the movement will be more sloping than the infection process in the pre-vaccination period. The number of individuals in subpopulation *E* continues to grow since the

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beginning of the simulation. The number of individuals in subpopulations *I* and *Q* has increased slightly since the beginning of the simulation. The number of individuals in subpopulation *R* continued to increase slightly over time.

The second simulation will use the value $\delta_1 = 0.25$, $\delta_2 = 0.25$ and $\delta_3 = 0.5$ for simulation time 60 month. The results of numerical simulation are shown in the following figure:

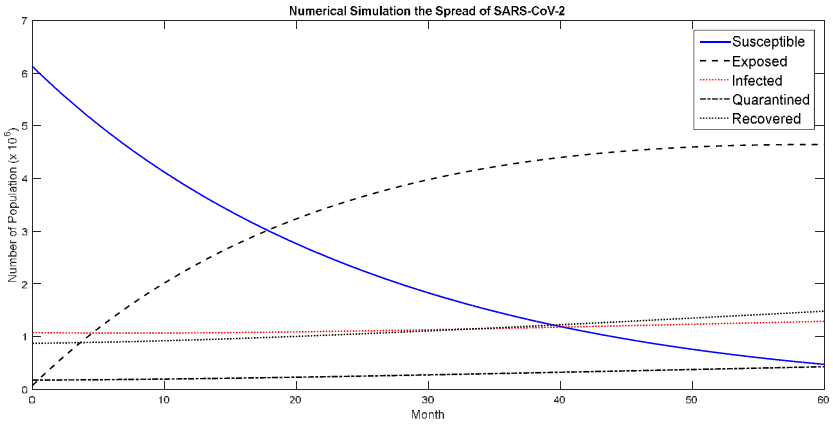


Figure 4. Stability of SEIQR model for the spread of SARS-CoV-2 after vaccination $(\delta_1 = 0.25, \delta_2 = 0.25, \delta_3 = 0.5)$

The graph in Figure 4 shows that the numbers of individuals *S*, *E*, *I*, *Q*, and *R* are stable for the long term. Since the start of the simulation, the number of individuals in subpopulation *S* has continued to decrease, while the number of individuals in subpopulation *E* has continued to increase. The number of individuals in subpopulations *I* and *Q* increased insignificantly. The number of individuals in subpopulation *R* continues to grow slightly over time.

The third simulation will use the value $\delta_1 = 0.5$, $\delta_2 = 0$ dan $\delta_3 = 0.5$ and the graph is the following figure:

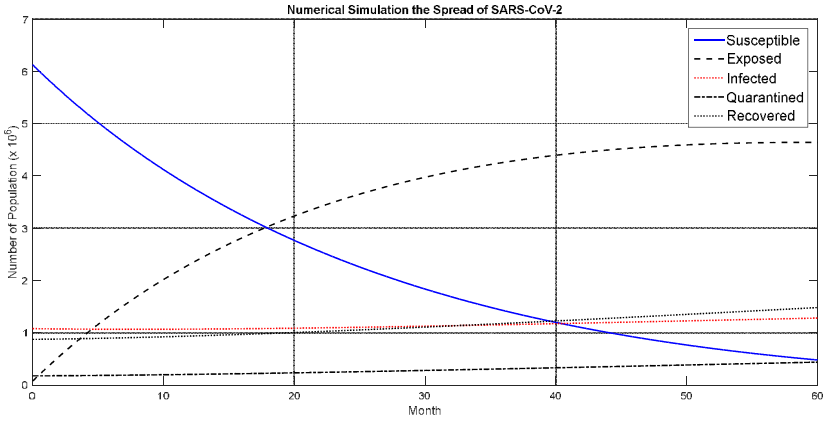


Figure 5. Stability of SEIQR model for the spread of SARS-CoV-2 after vaccination $(\delta_1 = 0.5, \delta_2 = 0, \delta_3 = 0.5)$

The graph in Figure 5 shows that the numbers of individuals in subpopulations *S*, *E*, *I*, *Q*, and *R* are stable for the long term. The number of individuals in subpopulation *S* has decreased since the beginning of the simulation. The number of individuals in subpopulations *E*, *I*, *Q*, and *R* initially has insignificantly increased.

Using three different variations of δ_1, δ_2, δ_3 the comparison of subpopulations *I* is shown in the following figure:

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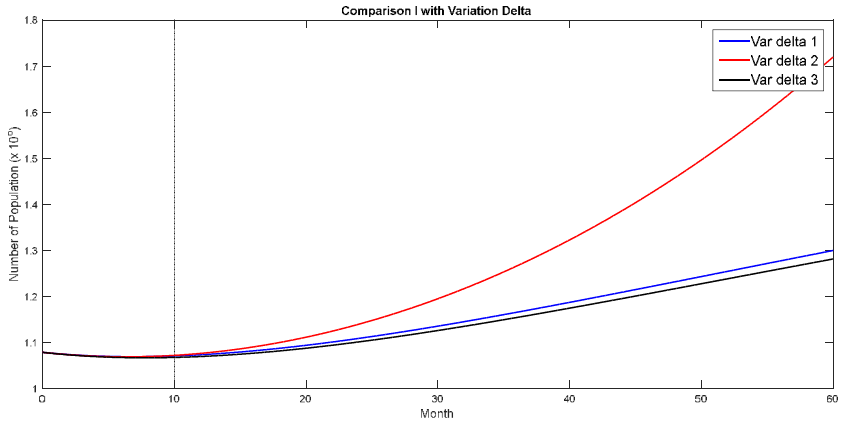


Figure 6. Comparison of the number of subpopulations *I* by varying the value of δ_1, δ_2, δ_3

The graph in Figure 6 shows the comparison of the number of subpopulations *I* by varying the value of δ_1, δ_2 and δ_3. Comparison in the first simulaion, second simulation, and third simulation in after vaccination period were shown by Var delta 1, Var delta 2, and Var delta 3. The results showed that Var delta 3 was better at suppressing the of subpopulations *I*. This means there is an urgent need to control the spread of Covid-19 by respecting the quarantine process and restricting movement.

Conclusions

The SEIQR model modified by the spread of SARS-CoV-2 has two critical points, namely disease-free and endemic critical points. Both critical points are stable if the inequality constraints on the parameter value are satisfied. Numerical simulation of the spread of SARS-CoV-2 were performed in his two simulated periods pre-vaccination and post-vaccination. The infection process in the suspect group will continue in both periods. The infection process in the post-vaccination period was slower than in the pre-vaccination process. Restrictions on population mobility and quarantine of exposed and infected individuals can slow down the infection process. This effort will help limit or break the chain of infection.

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Analysis of students' numerical literacy ability test based on Barus coastal culture

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Abstract. *One of the skills needed in the global era is mathematical literacy. This study found that the students' mathematical literacy is still low, especially numerical literacy. Based on the observation made on the student's ability in answering a test related to students' numerical literacy, it can be seen that the aspect regarding students' understanding is still low. The application aspect also indicates that students cannot analyze a picture showing an angle of the same measurement. Meanwhile, the reasoning aspect also indicates that students are not able to create ideas or express their ideas, so they still cannot solve the problem effectively. To achieve the objective of the mathematics lesson, one of the skills required for students to master is mathematical numerical literacy. The formulation of this study is to see students' numerical literacy skills based on Barus coastal culture in the VIII grade students of MTs laboratory UIN SU Medan. This research follows descriptive qualitative research. This study concludes that the student's understanding of facts, procedures, and tools in mathematics is good. This can be seen from the answers obtained from the students in that 83% of students can understand the questions well. In the application aspect, students are seen to apply the mathematical concept in a real and routine situation. The improvement can be seen from the answers obtained from students in that 70 % should be improved. In the reasoning aspect, the students can be seen to have the ability in analyzing mathematical concepts to solve non-routine problems. This needs some improvement as it can be seen from students' answers that 50% of students' ability in this aspect needs to be improved.*

Keywords. literacy, numeracy, mathematics, culture, pesisir, barus

Introduction

One of the skills needed in the global era is mathematical literacy [1] but the reality shows that the majority of mathematical literacy skills are still low [2] supported by the report of the Organization for Economic Co-operation and Development (OECD) that the *Program for International Student Assessment* [3] PISA 2018 Indonesia shows that the quality of education in Indonesia is low. Subjects' mathematics has decreased compared to the previous year. The ability of students'

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mathematical literacy in Indonesia according to the PISA study is still relatively low compared to other countries and can only complete 2 out of 6 levels of mathematical literacy. [4] and supported by data on Indonesia's literacy rate in research in 70 countries where it is at number 62, the 10 lowest countries with low literacy levels [5].

This can also be seen from the results of observations of students' abilities in answering questions on the mathematical literacy ability test given in class VIII MTs Laboratory of IAIN SU Medan. From the results of the student's answers, it can be seen that the Comprehension Aspect is still lacking, students are not able to write down ideas or ideas from questions, the Application Aspect is still low, students are unable to use mathematical concepts to solve problems correctly and the Reasoning aspect is also still low because students are unable to explain ideas/concepts to solve questions.

Mathematical literacy is important to develop because it finds solutions to everyday contextual problems which is also the essence of the goals of learning mathematics. Mathematical literacy is not easy to measure because the substance has many components that require lots of reading [6]. Given the importance of developing these skills, the Ministry of Education and Culture's Assessment and Learning Centre has developed a Minimum Competency Assessment (AKM). [7] proposes that the development of competency tests is based on an assessment of verbal reasoning skills (literacy) and numerical data-based reasoning skills (numeracy), and in accordance with the PISA concept. AKM has three components: content, context, and cognitive processes. One aspect of AKM is measuring students' cognitive learning outcomes. Content that is measured includes literacy and numeracy. This is important and ongoing content that transcends value and level. At least because not all content in the syllabus has been tested. The Ministry of Education and Culture (Kemendikbud) has been trying to form the National Literacy Movement (GLN) since 2016 to create a culture of literacy among students. This is an implementation of character building from Permendikbud No. 23 of 2015. 1. Linguistic Literacy (2) Numerical Literacy (3) Scientific Literacy (4) Digital Literacy (5) Financial Literacy (6) Cultural and Citizenship Literacy. Literacy is a person's ability to improve reading, writing, speaking, and arithmetic skills.

Numerical literacy is the knowledge that uses numbers, calculations, formulas, and shapes and can solve problems and analyze those presented in the form (graphs, tables, charts and others) and it can be interpreted that Numerical Literacy is a person's ability to engage in the use of reasoning means understanding and analyzing a statement. Numerical literacy is a skill that every student must have by using numbers and data in order to make it easier to solve problems in hot questions. [8] states that numeracy literacy is defined as a person's ability to use reasoning. The focus of this numeracy literacy ability is that students can formulate, apply, and interpret mathematics into various contexts that include mathematical reasoning and use mathematical concepts, procedures, facts, and tools to describe, explain, and predict phenomena in everyday life. Numerical literacy is a part of mathematics so that components in numeracy literacy cannot be separated from the study of mathematical material

[9] suggests three important aspects of numeracy literacy skills, namely counting, numerical relations, and arithmetic operations. Counting is the ability or skill in identifying the number of an object and skills in counting an object verbally. Numerical relations relate to students' ability to relate the quantity of an object, such as less, more, higher, or lower. Meanwhile, arithmetic operations are the ability to complete basic mathematical operations such as subtraction, addition, multiplication, and division.

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Numerical literacy can be used to solve mathematical problems and in everyday life by analyzing information and interpreting the results of analysis to calculate and make decisions [10]. Good numeracy literacy will give birth to students who are skilled at using mathematics confidently at school and in everyday life. Numerical literacy ability is one of the determinants of the progress of a nation. In accordance with the times, the educational curriculum also demands cultural in learning in schools [11]. So far these cultural concepts are rarely associated with learning in schools, so that many of the nation's future generations forget or even do not understand the meaning of existing culture. Cultural practices allow the embedding of mathematical concepts. [12] there are 7 elements of culture that we can find in all nations in the world. The seven elements that we can call the main contents of every culture in the world are: language, knowledge system, social organization, system of living equipment and technology, system of livelihood, system of religion and art. Such as the Barus Coastal Culture which includes part of that culture as an element of art which is used in one of the traditional wedding ceremonies and circumcision of the apostle (circumcision) using *sikambang* [13]. This cultural element is used as a test instrument in the numeracy literacy skills of artifact elements (cultural tools).

Numerical literacy

Literacy skills relate to the ability to apply knowledge, principles and processes of mathematics to problems in everyday life, for example understanding problems presented in tables or diagrams, trading, and so on. According to the Ministry of Education and Culture (2020) numeracy is defined as the ability to think using mathematical concepts, procedures, facts, and tools to solve contextual problems in everyday life that are suitable for individuals as good citizens.

Numerical literacy is knowledge and skills (1) acquiring, interpreting, using, and communicating various mathematical numbers and symbols to solve problems in various life contexts; (2) analyzing information to make decisions [14] . According to [15] the scope of numeracy literacy is the skill of applying mathematical concepts and rules in real everyday situations when the problems are often unstructured, have many ways, and there may not be a complete solution.

Numerical literacy is a person's ability to acquire, interpret, use, and communicate various kinds of mathematical aspects (numbers and symbols) to solve practical problems in everyday life [16]. In simple terms, numeracy literacy can be interpreted as the ability to apply number concepts and arithmetic operations skills in everyday life (for example, at home, school, work, or society) and the ability to interpret quantitative information found around us.

Numerical literacy is practical (used in everyday life), related to citizenship (understanding issues in society), professional (in work), recreational (for example, understanding scores in sports and games), and cultural (as part of deep knowledge and civilized human culture). From this it can be seen that the scope of numeracy literacy is very broad, not only in mathematics, but also intersects with other literacy, for example, cultural literacy and citizenship.

The structure of numeracy literacy in Numerical Literacy Supporting Materials published by the Ministry of Education and Culture [17] (Han et al., 2017)is as illustrated below:

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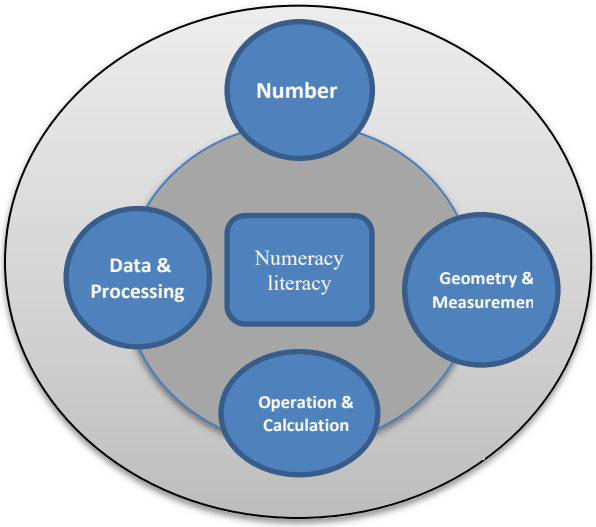


Figure 1. Overview of numerical literacy structure
Source: Numerical literacy supporting materials, ministry of education and culture

Numerical literacy requires knowledge of mathematics that is learned in the curriculum. However, learning mathematics itself may not necessarily develop numeracy skills if it is not designed in such a way.

Methodology

This type of research is a qualitative research that aims to describe students' numeracy abilities based on students' initial abilities. According to Miles and Hiberman, data analysis techniques are used, namely data reduction, data presentation, and drawing conclusions. Meanwhile, to test the validity of the data, a method triangulation process was carried out, namely comparing test results data and interview data. The research used was descriptive qualitative research. Descriptive research is collecting data in the form of sentences, illustrations, and not numbers (Moleong, 2005). The approach used is a qualitative approach. Qualitative research referred to in this study is the method or research technique by decomposing descriptive facts into words or language from actual events. The procedure for this research went through the preparation stage : Appointing the school where the research would be carried out, namely the MTs Laboratory of UIN SU Medan, Making initial observations at the school where the research would be carried out as well as asking for permission to carry out the research, Making research designs/designs, Arranging instruments for testing numeracy literacy skills, a grid of questions and an assessment rubric, Trial tests the ability of numeracy literacy to see the validity and reliability of the test. Implementation stage: Giving a numeracy literacy test to students, Checking the answers of all students according to the scoring instructions, Accumulating all the data obtained. Data analysis stage: Describe the results of students' answers in solving the numeracy literacy ability test questions, Conduct data triangulation. Final stage**:** Presenting research results and drawing conclusions.

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Research instruments

Instruments in this study are equipment or devices in conducting research to accumulate data or information so that it is more concise and easier for further processing. (Sugiyono, 2019) revealed that in qualitative research the main instrument is the researcher himself. So apart from the researcher as the main instrument, there are also supporting instruments that are used, namely Numerical literacy ability test question. Instrument used in this research is the Numerical Literacy Ability Test based on the Barus coastal culture. The numeracy literacy ability test is presented in the form of 4 number word problems using artifact questions from that culture and will reveal 3 indicators, namely (1) Understanding, understanding facts, procedures and mathematical tools., (2) Application, being able to apply mathematical concepts in real situations that are routine, and (3)Reasoning, reasoning with mathematical concepts to solve non-routine problems.

Discussion

The numeracy literacy ability test that has been prepared consists of 4 essay test questions first tested to measure the validity and reliability of the test.

VALIDITY TEST RESULTS:

Table 1. Correlations

		Question 1	Question 2	Question 3	Question 4	TOTAL
Question 1	Pearson Correlation	1	.574*	.223	.236	.711**
	Sig. (2-tailed)		.016	.390	.361	.001
	N	17	17	17	17	17
Question 2	Pearson Correlation	.574*	1	.453	.625**	.860**
	Sig. (2-tailed)	.016		.068	.007	.000
	N	17	17	17	17	17
Question 3	Pearson Correlation	.223	.453	1	.594*	.749**
	Sig. (2-tailed)	.390	.068		.012	.001
	N	17	17	17	17	17
Question 4	Pearson Correlation	.236	.625**	.594*	1	.730**
	Sig. (2-tailed)	.361	.007	.012		.001
	N	17	17	17	17	17
TOTAL	Pearson Correlation	.711**	.860**	.749**	.730**	1
	Sig. (2-tailed)	.001	.000	.001	.001	
	N	17	17	17	17	17

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

with $N = 17$, it is known that $r_{table} = 0.4821$. Based on the results of the validity test output, it is concluded that:

Question 1 =VALID, because
$r_{hitung} > r_{tabel} = 0.711 > 0{,}482$
$p_{value} < \alpha = 0.001 < 0.05$
Question 2 = VALID, because

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$r_{hitung} > r_{tabel} = 0.860 > 0{,}482$
$p_{value} < \alpha = 0.000 < 0.05$
Question 3 = VALID,because
$r_{hitung} > r_{tabel} = 0.749 > 0{,}482$
$p_{value} < \alpha = 0.001 < 0.05$
Question 4 = VALID, because
$r_{hitung} > r_{tabel} = 0.730 > 0{,}482$
$p_{value} < \alpha = 0.001 < 0.05$

Table. 2. Validity

No	r_{hitung}	r_{tabel}	p_{value}	α	Conclusion
1	0.711	0.482	0.001	0.05	VALID
2	0.860		0.000		VALID
3	0.749		0.001		VALID
4	0.730		0.001		VALID

Thus, it can be said that the test instrument is valid for each item.

Table. 3. Reliability

Reliability Statistics	
Cronbach's Alpha	N of Items
.727	4

Based on the reliability output, it is found that the estimated value of Cronbach's Alpha > 0.65, which is 0.727 . So it can be concluded that the test instrument is reliable.

The four instruments were declared valid and reliable, so we then tested them on class VIII circle material. The results of the analysis of the items are explained as follows:
Item Number 1.

Indicator Comprehension based on the data from the results of the numeracy literacy test for 17 students, it was found that there were 14 students who had achieved the highest score, very good understanding of the concept questions, only 3 more students still low on this indicator. Indicator Application , data were obtained that there were only 3 students who were very good, 10 students were quite good, 4 students were still not good enough, on the Reasoning , data were obtained that there were no students who were very good at being able to solve questions correctly and completely, students' abilities were only can be at a fairly good level, there are even 2 students who cannot answer at all.
Item Number 2.

Indicator Comprehension based on the data from the results of the numeracy literacy test for 17 students, it was found that 15 students had achieved the highest score with a very good understanding of the concept of the questions, only 2 students were still low on this indicator. Indicator application , it was found that there were no students who were very good at being able to understand the questions correctly and completely, 11 students were quite good, 6 students were still not good enough, but all students had answered all the sub-questions in the questions. Indicator Reasoning , it was found that there were no students who were very good at being able to understand the questions correctly and completely, students' abilities could only be at a fairly good level, 8

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students and 8 students were not good because they could only achieve a score of 1, in fact, there was 1 student who did not can't answer.

Item Number 3

Indicator Comprehension based on data from the results of the numeracy literacy test for 17 students, it was found that 13 students had achieved the highest score with a very good understanding of the concept, 2 students who were still good enough got a score of 2 and there were 2 students who unable to fully understand the concept of the problem. Indicator application , it was found that 15 students achieved the highest score in the *very good* to be able to understand the questions correctly and completely, only 2 students who were still not good enough could not answer all the sub-questions in the questions. Indicator Reasoning, the data obtained is that there is only 1 student who is very good at being able to solve the problem correctly and completely, students' abilities can only be at a fairly good level with a score of 2, namely 10 students while score 1 has 3 students but there are still 3 students who are not at all can answer.

Item Number 4

Indicator Comprehension based on data from the results of the numeracy literacy test for 17 students, it was found that 10 students had achieved the highest score with a very good understanding of the concept, but there were 7 more students who were unable to understand the concept of the problem at all.indicator Application , it was found that 11 students achieved the highest score in the *very good* to be able to understand the questions correctly and completely, but there were 6 other students who were unable to understand the concept of the questions at all (blank answers).indicator Reasoning , the data obtained were that there were 9 students who were very good at being able to solve the questions correctly and completely, 3 students answered quite well but there were still 5 students who could not answer at all. After being analyzed and obtaining the ability of students to solve problems in the mathematical literacy ability test, we then conducted interviews with 3 children.

Conclusion

Based on the results of the research and discussion, the following conclusions can be drawn:

1. Students' numeracy literacy skills with indicators of understanding, application and reasoning 2
2. Understanding, *understanding facts, procedures and mathematical tools* are good, as can be seen from the results of the answers given obtained by students in question number 1 there were 14 students, in question number 2 there were 15 students, in question number 3 there were 13 students and in question number 4 there were 10 students who answered correctly and completely out of 17 students overall or 83% of students were able to understand the concept of question
3. Ability Application, *being able to apply mathematical concepts in real situations that are routine in nature* needs improvement as seen from the results of the answers obtained by students in question number 1 there were 10 students who answered quite well, in question number 2 there were 11 people quite good, in question number 3 there were 15 students achieving a score the highest category *is very good* and question number 4 there are 11 students achieving the highest score in the *very good* and complete category of 17 students as a whole, at this stage the application ability of students still needs to be improved.
4. Reasoning, *reasoning with mathematical concepts to solve non-routine problems.* Need improvement can be seen from the results of the answers obtained by students on question

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number 1 no students have been able to complete the question correctly and completely, question number 2 and question number 3 only question number 4 there are 9 students achieving the highest score in the *very good* of the 17 students overall then in At this stage, the application ability of students still needs to be improved.

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The validity of information technology and data literacy courses materials to improve digital literacy skills for physics students

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Abstract. *The low digital literacy skills of students and the lack of uniformity of teaching materials used in information technology and data literacy courses are a problem. this is because the information technology and data literacy courses are one of the basic foundations for students to complete lectures in the physics department at the Medan State University. Through this research, a teaching material has been developed using the development research method of Thiagarajan (1974) which consists of 4 stages, namely define, design, development, and dissemination. The teaching materials produced in this basic research are limited to the validation process by the material expert and media expert. The results of the instrument were analyzed quantitatively descriptively. The average result of the material expert's validation assessment of teaching materials for all indicators was 84.9% or in the highly valid response category and the media expert's average assessment was 88.4% or in the highly valid response category. These results indicate that the learning device product has fulfilled the feasibility test based on the validator's assessment and further limited and large-scale trials can be carried out on students.*

Keywords: validity, digital literacy skills, ITDL, teaching material

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Introduction

Digital literacy is the ability to make good use of digital technology for the creation, communication, collaboration, and search and evaluation of information in a digital society. This includes the ability to utilize digital devices to achieve goals. [2]. Unesco defines digital literacy as the ability to access, manage, understand, integrate, communicate, evaluate, and create information safely and appropriately through digital technology for employment, decent work, and entrepreneurship [5]. From the definition above, students who have advanced digital literacy skills will be able to evaluate information and distinguish between facts and fake news, avoid negative behavior in utilizing social and digital media, and be able to exchange information digitally safely.

To equip this, information technology and data literacy courses are a solution provided by the Faculty of Mathematics and Natural Sciences as a faculty compulsory subject. It is hoped that through this course, graduates' digital literacy skills can increase. This is in line with the course description which discusses progress and skills in information technology related to the use of digital data-based computers including search, access to information, operating systems and applications.

However, in reality, the digital literacy skills of students majoring in physics at Medan State University are still relatively low. From the data from the results of plagiarism detection examinations for students majoring in physics in 2021. Initial examination of student thesis shows 85% of the results of plagiarism detection with an average score above 50% of the total application submissions. These results indicate the low ability of students in the ability to adapt information which is an important element in digital literacy. This phenomenon also shows the tendency of students not to show literacy ethics in collecting and utilizing information from various sources. Copy and paste activities are still a common thing for students without doing a review and paraphrasing of the information obtained.

One of the efforts made as a learning facilitator to overcome the problem of low student digital literacy is to design and develop teaching materials for Information Technology and Data Literacy courses that can improve students' digital literacy skills. The topic of discussion of the teaching materials developed must pay attention to the elements of digital literacy, namely the ability to search for information and evaluate (information search and evaluation), create (creation), communication (communication), collaboration (collaboration), and online safety (online safety) [1]. Through this research, the validation of teaching materials that have integrated these elements is expected to have a direct impact on students' digital literacy skills.

Methodology

This research was part of research and development study of Information Technology and Data Literacy Courses Materials. To improve students' digital literacy skills, Digital Literacy elements, such as are integrated into the course teaching materials. Teaching materials in research use the 4D development model proposed by Thiagarajan, Semmel, and Semmel [4] which consists of four stages, namely the define stage, the design stage, the development stage, and the dissemination stage. However, this research limits the activities to the development stage, namely the type of trial activity as an improvement in learning tools.

The Learning courses materials are then validated by material and media experts. Validator responses were collected in the form of a Likert scale of 1-5 and then the total score divided by the maximum score. The results are then analyzed using the guideline proposed by Sugiyono [3] to assess the feasibility of the learning materials developed.

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Result and discussion

To find out the feasibility of the content of information technology teaching materials and data literacy developed, teaching materials are validated in advance by material experts. Validation is related to the assessment of content feasibility aspects, presentation feasibility, and language aspects. The results of the material expert validation can be seen in Table 1.

Table 1. The validity of teaching material content

Indicator	Response Percentage	Criteria
Feasibility Of Content		
Conformity of the material with Learning Outcomes	93.3	Highly Valid
Material Accuracy	86.25	Highly Valid
Supporting Learning Materials	85	Highly Valid
Material Update	82.5	Highly Valid
Aspect Of Feasibility Of Presentation		
Presentation Techniques	95	Highly Valid
Presentation Support	90	Highly Valid
Completeness of Presentation	93.33	Highly Valid
Language Aspect		
Straightforward	83.33	Highly Valid
Communicative	80	Valid
Dialogic and interactive	75	Valid
Consistency and integration of thoughts	75	Valid
Use of terms, symbols, or icons.	80	Valid
Average	84.9	Highly Valid

The results above show that the material expert's assessment states that the teaching materials made are very valid. The highest percentage of response is 95% which is an indicator of delivery techniques where the lowest is 75, namely indicators of Dialogic and interactive as well as Consistency and integration of thoughts. Regarding these results, the validator's input is for teaching materials to use consistent terms and use a simpler style of language so that it is easily understood by readers.

The validation of teaching materials from media experts consists of several indicators, namely, the size of teaching materials, the use of fonts, layouts, illustrations, pictures and photos as well as the display design of teaching materials. The media expert validation results are shown in Table 2.

The results above show that in terms of media, the teaching materials made are valid. The highest percentage of response is 100%, which is an indicator of the size of teaching materials where the lowest is an indicator of illustrations, pictures and photos used in teaching materials of 80%. Regarding these results, the validator suggested that the resolution of illustrations and images used in teaching materials should be improved to make them more visible to reader. The input given by media experts is used to improve teaching materials.

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Table 2. The media expert validation results

Indicator	Response Percentage	Criteria
The size of teaching materials	100,0	Highly Valid
The use of fonts	90,0	Highly Valid
Layout	84,0	Highly Valid
Illustrations, pictures, photos	80,0	Valid
Display Design of teaching materials	88,0	Highly Valid
Average	88.4	Highly Valid

Conclusions

The designed Information Technology and data literacy teaching materials have fulfilled the feasibility aspect through the validation process of material and media experts. the conclusion from the validation of material and media experts is that the teaching materials developed are in a very valid aspect. This conclusion means that the developed teaching materials are feasible to proceed to the open trial stage at the next research stage.

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Implementation of tudiamipa as an alternative to online learning

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Abstract. *The development of MOOCs at FMIPA Unimed was carried out in 2020 under the name TUDIAMIPA which can be accessed at http ://:leraning.tudiamipa.com. Tudiamipa is a MOOCs System developed to answer learning activities' problems during the Pandemic Covid 19. Tudiamipa is also present to increase student competence, such as making learning media, animations, and laboratory management skills. In addition, the MOOCs system with Tudiamipa also provides an opportunity for students to get a certificate accompanying diploma after participating in learning at Tudiamipa . From the results of the questionnaire given, it is illustrated that the respondents stated the software engineering aspect with an average of 4.2 with a decent category, for visual communication aspects with an average of 4.3 with a very decent category and for learning aspects with an average of 4.6 with very decent category.*

Keyword: MOOCs, Online learning, Covid

Introduction

Independent Learning Policy Independent Campus is expected could Become an answer to demands. Kampus Merdeka is existing learning in college autonomously and flexibly, so which created an innovative learning culture, no restraint, and is appropriate to the needs of students[1]. main program namely: convenience opening of the study program new, change system accreditation college height, convenience college state university to become an incorporated PTN law and rights study three semesters outside the study program[2].

Various form activity study outside college high, among other things Doing internship/practice work in Industry or the place, work others, carrying out project devotion to the community in the village, teaching in the unit education, following exchange students, doing research, do activity entrepreneurship, create studies/projects independent, and follow the humanitarian program. All activities must be held with guidance from the lecturer. Campus independence expected could give experience contextual to the field to increase the competence of students in a manner whole, ready work, or create field work new.

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Responding problem this need to conduct a learning process development teach which could cover Standard Competence from graduates, besides it's also easily accessed were just. Massive Open Online Courses (MOOCs) are here as cleavage problems for reaching competence from a graduate of college high, so students could obtain certificate diploma companion [3]. MOOCs are system learning online / online based accessed through the internet network, so participants educate moment this could to do activity study teach no limited again by space and time at will hear them.

Development of MOOCs at FMIPA Unimed once done in 2020 with the name TUDIAMIPA that can be accessed at http//:learning.tudamipa.com [4]. Developed MOOCs system for answer problem activity learning during the Covid 19 Pandemic. Tudiamipa was also present in framework enhancement competence students for example making learning media, making animation, as well as Skills management laboratory [5].

Massive open online course (MOOC) is one of the e-learning platforms for learning online (online). If seen from the side of the learning process teaching, learning MOOC based not far different from learning conventional: has a teacher/ instructor, syllabus, teaching materials and materials, and exams. A few MOOC providers also provide certificates as a sign of graduation at the end course. However, in a manner general, there are three things that set it apart from the method learning conventional: (1) learning process in MOOC is not conducted in class but through screen computers or smartphones. Whole Theory learning is good in that it delivers teaching materials, questions training, as well implementation exam, packed online in digital format. Delivery materials and teaching materials usually be delivered through video recordings, presentation slides, or in a manner textual; (2) MOOC is open, got followed by whoever just. Registration no requires qualification or graduate education certainly, so all free internet users register and follow learning. Learning models in MOOC is informal, unlike a learning process taught at school. And (3) MOOC is designed could accommodate participants with an amount that is not limited. because that is, interaction Between instructor and participants is more characteristic of collective and communal, not individual [6].

MOOCs were first introduced in 2006 and are emerging as a popular learning mode in 2012 [7]. MOOCs are present as a new model of education and learning, which uses the internet in convey Theory lectures at college heights and institutions education prestigious world, creating a sort of revolution and these people each other join for to do course sustainable. Learning models sustainable called "Massive Open Online Courses" abbreviated as "MOOCs"[8], create learning models from shared available corners of the world for the course, every student could access the programs offered by the shared college high, institution education and organizations education. MOOCs are learning models online based that can access by everyone around the world corners of the world for free [9]. Though there are worries that this could bring distraction and reduce the quality of education in college high, MOOCs can define return draft education college tall by giving an opportunity to study new candidate students in faculties and universities for getting Skills as good maybe.

Methodology

Research location this was conducted at FMIPA Medan State University with time research in the odd semester of 2021/2022. The population study is whole FMIPA students at Medan State University and the sample study is student taking subject design development of IT-based educational media at FMIPA, Medan State University. The approach used in the study is

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approached qualitatively because the researcher wants to dig into the development, implementation, and impact of the use of Tudamipa MOOCs at FMIPA Unimed. Study qualitative use method qualitative that are observation, interview, or study document. Method qualitative this used because of several considerations. First, customizing the method qualitative easier if face to face with reality plural. Second, method this serves in a manner direct essence connection Between researchers and respondents. Third, method this more sensitive and could adapt self with many sharpening influences together to patterns the value faced.

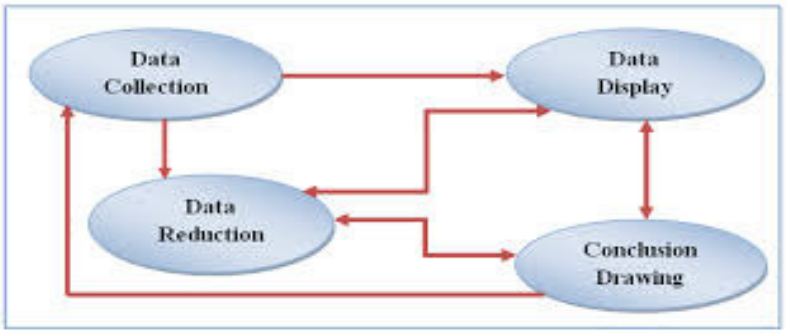


Figure 1. Data analysis

According to Bogdan and Bikien study case is testing in a manner detail to one background or one subject _ or one place storage document or one incident certain [10]. Limits approach studies case as something approach with concentrated attention to something case in a manner intensive and detailed. While Yin gives more limitations and characteristic technical with an emphasis on features. Ary, Jacobs, and Razavieh explain that in studies cases should researcher attempt a unit test or an individual [11].

Result and discussion

From the research results obtained Development of MOOCs at FMIPA Unimed already there a number of Theories like Vibrations and Waves, Learning Media Android-based, Engineering Physics, Physics General, Calculus, Physics Mathematics, Basic Blender, Creating animation flat with Flash, and others. for clearer could see in the picture following:

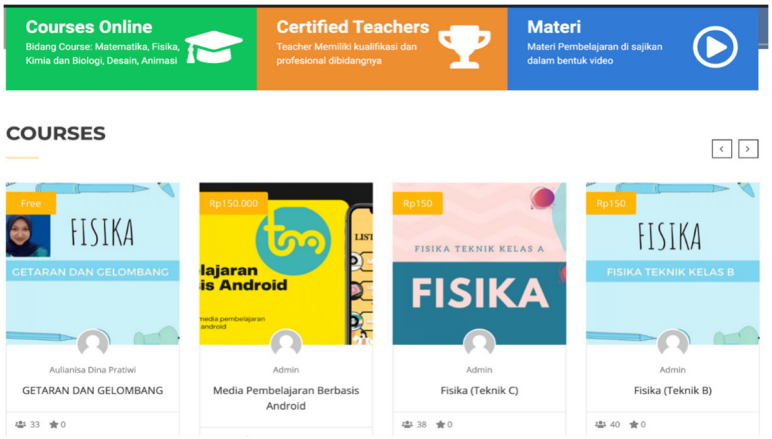


Figure 2. MOOCs site Tudamipa

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Results of given questionnaire to respondents could see in the table under this:

Table 1. Questionnaire Response to Implementation of Tudamipa's MOOCs

Aspect	Indicator	Total score	Average	Category
Software engineering	Reliabel	250	4,1	Worthy
	Usability (easy to use)	132	4,4	Very Worth it
	Use of navigation	127	4,2	Worthy
Visual communication	Communicative	268	4.45	Very Worth it
	Simple and charming	251	4,15	Worthy
	Visual quality	262	4.35	Very Worth it
	Use of mobile media	260	4.3	Very Worth it
	Audio usage	264	4.35	Very Worth it
Learning	motivational quality	266	4,4	Very Worth it
	Ease of learning media to understand	279	4.65	Very Worth it
	Clear flow	278	4,6	Very Worth it
	Appropriateness of exercises/tests with the material	285	4.75	Very Worth it
Amount		2,922	52,7	Very worth it
Average / mean		4.38		

From the results of the questionnaire given, it can be seen that respondents stated the software engineering aspect with an average of 4.2 with a feasible category, the visual communication aspect with an average of 4.3 with a very feasible category, and for the learning aspect with an average of 4.6 with very decent category

From the results of interviews conducted by several respondents, The data is processed as in the table under this:

Table 2. Interview results to respondent to implementation of Tudamipa's MOOCs

No.	id	Gender	Age	Comment	Suggestion
1	N1	Man	18	Hopefully can more increase	Hopefully can more increase
2	N2	Man	17	The material provided enough good anyway, but Dear I already forget about that	If my advice anyway yes if can better again that's it for Theory his
3	N3	Woman	17	Good easy understandable for those who understand, if not understand suffer he why no understand	My advice no there is, thanks
4	N4	Woman	16	good	hopefully could better in the future
5	N5	Woman	17	Very nice and easy understood	no ad

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6	N6	Woman	16	Opinion I is for increase motivation study student about learning it and can studied with distance far	My advice as students, though technology is also increasing advanced may the teacher teach student it can to offset it so his students easier understand Theory the
7	N7	Woman	17	delivery good	more developed again
8	N8	Woman	16	delivery Theory good	should more many uses example question for deepen Theory lesson
9	N9	Man	17	Great, material easy understood and structured with tidy.	Hopefully success
10	N10	Woman	17	response I Theory optical this is study pre-experiment with one group pretest-posttest design and use experiment test grades 1 and 2 are aimed for knowing appropriateness learning, results learn and respond student through application approach scientific on matter device optical.	My advice based on Theory this is location time moment teach because truly understand what to _ conducted and make sure in accordance with plan
11	N11	Woman	16	submitted material _ clear and easy understandable	hopefully in the future better again
12	N12	Woman	17	The lesson that I get from Theory Optics through MOOCs media easy for understood	Presumably our more each other Train and persevere in learn something Theory nor our experiments _ do.
13	N13	Woman	15	Learning media its very good	Learning media its very helpful other students for study
14	N14	Man	17	Learning This is very interesting, and the discussion is very inspiring as well as give easy - to- understand insights and learning	For in the future, I please the more many students who enlightened their future because of learning media this
15	N15	Man	17	Theory as well as easy - to-understand discussion for the students	Study no once interesting this, I hope that the mentors can forward what have _ they start, and don't bore for give lots of insight for generation young. thank you

Conclusion

From the results of the questionnaires given, it was found that respondents stated that aspects of software closure with an average category of 4.2 were feasible, aspects of visual communication with an average of 4.3 with a very feasible category, and aspects of learning with an average of

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4.6 with the category very worth it. From the results of interviews with respondents it was found that participants were very happy and motivated by using Tudamipa MOOCs

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Development of ailo-phy (android-based interactive learning media for physics) learning applications on optical materials

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Abstract. *Distance learning or better known as online learning is an obligation that must be carried out in almost all schools and universities in Indonesia. This is because the world is being shaken by the pandemic Corona Virus (Covid-19). The very current crisis conditions have caused direct face-to-face learning process activities to be stopped. The learning media that will be developed is Android-based learning media. Ailo-Phy Learning Application Development (Android-Based interactive Learning Media for Physics) In Optical Materials it is carried out based on procedures. The results of the development of the Ailo-Phy Application are then carried out with due diligence or validation by material experts, media experts who have been determined, and field trials on users. Based on the validation carried out on the Ailo-Phy learning application, it was declared feasible to continue in the field test. Based on the results of the assessment by media experts it was declared feasible to obtain an average percentage of 76.86%, the Ailo-Phy application is feasible to use because it meets the principles and criteria for developing learning media. Based on the results of field tests that were tested on 80 respondents, the results stated that the Ailo-Phy application was very feasible with an average percentage of 88.03% of respondents..*

Keyword: Mobile Learning, Android, Learning Media

Introduction

The use of cell phones, which is currently widespread, is a result of the fast-paced development of technology. It is estimated that one cell phone or more has been owned by almost 90% of students. The opportunities for using technological devices in education are increasing as more people own and use mobile devices. The need for using mobile Information and Communication Technology (ICT) devices, such as smartphones, is very high due to technological developments. According to the survey, smartphones or smartphones are used for communication purposes by 95.68 percent of the 6,250 respondents when not connected to the internet, and only 13.97 percent use smartphones for study. As shown in Figure 1.

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Figure 1. Smartphone user activity when not connected to the internet

Because smartphones have not only text and voice communication capabilities but also data and internet, they are mainly used for internet communication, accounting for around 93.46 percent of usage. Seeking information and entertainment has a usage rate of over 65 percent, while studying only accounts for 25.70 percent of usage..



Figure 2. Smartphone user activity when connected to the internet

One regrettable fact is that, although there is a predicted increase in cellphone users by 2025, the internet connection speed in Indonesia is still lagging behind several other Southeast Asian countries [1].

The learning media that utilize cell phone technology is known as Android-based learning media, which serves as an alternative to developing learning media. Some Android-based learning media require an internet connection, while others do not[2].

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Several advantages of using Android-based learning media have been identified by several researchers based on their research. According to Yahya, Android-based learning media can facilitate student learning in both class and independent learning settings, making it easy to access learning materials from various locations. This is due to the ease of use and accessibility of the media. [3]. According to Wulandari's research, the effectiveness of the learning process can be improved through interactive learning media, which can help students become more familiar with the material being studied as they repeat it more frequently. Interactive learning media also has the ability to convey messages and the content of lessons effectively while accommodating student responses. [4].

To address the aforementioned issues, the development of a learning media that is tailored to the needs of teachers and students is deemed necessary to enhance their ability in grasping physics concepts. Consequently, Android-based learning media is selected for the development of learning media. The research conducted by the authors is focused on the development of an Android-based interactive learning media for physics, specifically on Optical Materials, which is called the AILO-PHY Learning Applications [5].

The word "media" is derived from Latin and is, in fact, the plural form of the word "medium", which literally refers to an intermediary or the means of delivering messages from the sender to the recipient of the message [6]. A different interpretation of the term "media" is provided by the National Education Association (NEA), which regards them as forms of communication, including printed and audiovisual materials and their corresponding equipment. The NEA emphasizes manipulability and the ability to perceive media through sight, hearing, and reading. Similarly, the Association of Education and Communication Technology (AECT) in Arief S. Sadiman, et al. defines learning media as channels and forms that people use to convey messages or information, setting certain limitations to the definition [7].

In achieving learning goals, the media assumes a crucial role. Using media can enhance and optimize communication between teachers and students, rendering it more effective and efficient. In the teaching and learning process, media plays two significant roles: (1) as a teaching aid or so-called dependent media, whereby its effectiveness as a tool is highlighted, and (2) as a learning resource used independently by students, also known as independent media. Independent media is systematically designed to deliver information in a targeted manner that corresponds to the predetermined learning objectives [8].

According to Hartanto[9], it is stated by E. De Corte learning media is a non-personal tool that is used or provided by teaching staff who play an important role in the teaching and learning process to achieve instructional goals. Similarly, in Sunaryo Soenarto [10] Briggs defines learning media as a physical means for conveying the contents of messages.

Methodology

The research was conducted at the Faculty of Mathematics and Natural Sciences, Medan State University during the odd semester of 2021/2022. The research population comprised all students of FMIPA, State University of Medan, and the research sample consisted of students who took General Physics at FMIPA, State University of Medan.

The research method in this study is based on a scientific procedure to obtain data that fulfills the research objectives. The Research and Development (R&D) method is used for this research. According to Sugiyono [11], the R&D method is used to produce certain products and test their effectiveness. The development design is a framework or design that outlines the steps taken by

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researchers in developing Android-based learning media. The MDLC (Multimedia Development Life Cycle) method is used in this development research. The MDLC development method consists of 6 stages, which include concept development, design, material collection, assembly, testing, and distribution.

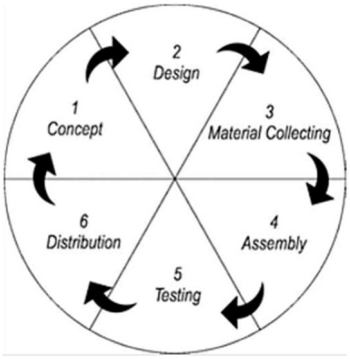


Figure 3. MDLC method stages

Phy Application Design as Mana Flow chart below

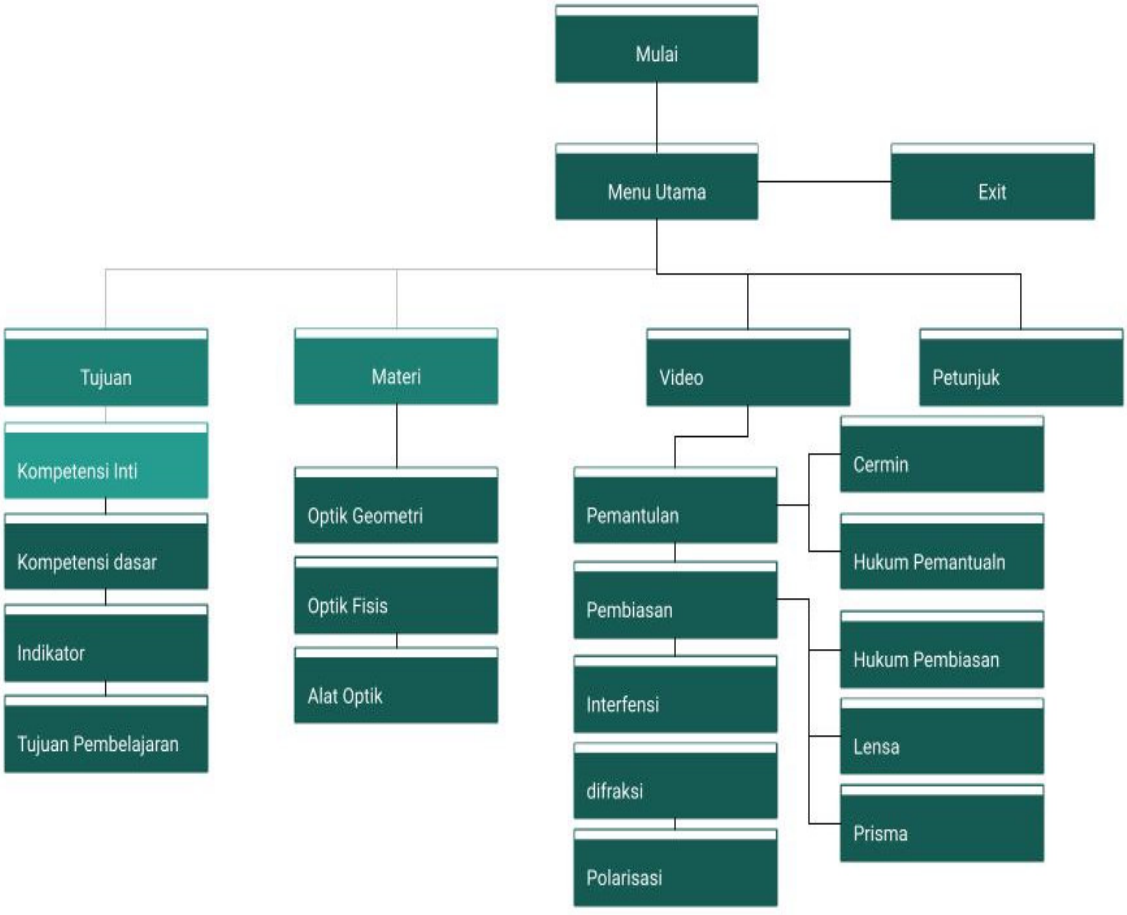
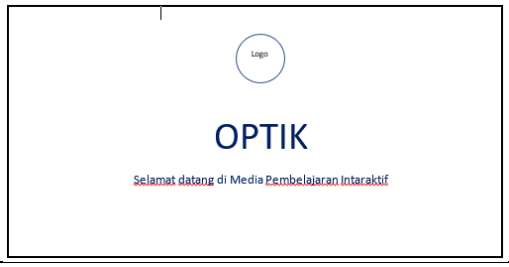
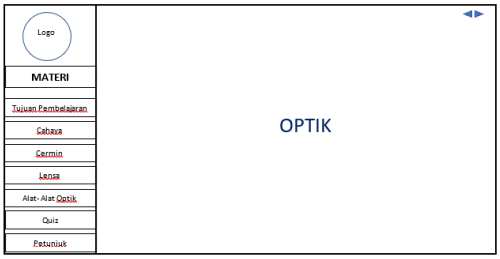
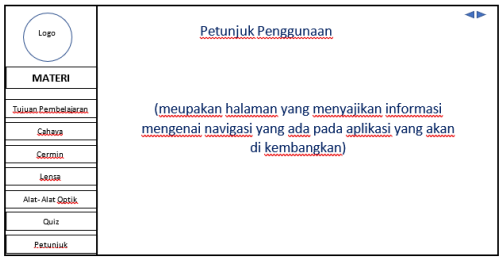
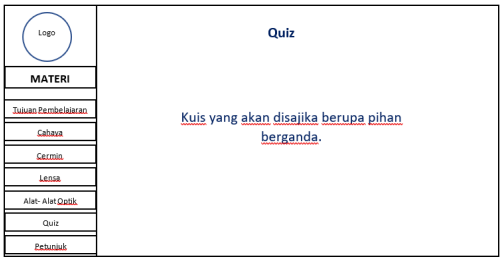


Figure 4. Flowchart diagram AILO- Phy

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Storyboards is an overview of learning media that will be loaded in the application. The storyboard functions as a guide like a map to facilitate the media creation process. Storyboard development design stages learning media that will be made are:

Table 1. Storyboards

No	Visual	Information
1		Initial View. The initial display is the first display when the learning media application is opened on the Smartphone. In this initial display, there is the Medan State University logo, a welcome sentence to interactive physics learning, and a start button.
2		Initial Menu On the initial menu, there are several menus that can be accessed according to user needs. The menu buttons available on the main menu are Learning Objectives, Light, Mirrors, Lenses, Optical Instruments, Quiz, and Instructions for using the application.
3		In this view is a display where the content is presented consisting of the title of the material and the contents of the material in the form of text, images, animations, videos that will be presented.
4		Instructions page is a notification page regarding the use of navigations in running the product to be developed.
7		On the quiz display there is a menu of multiple-choice questions. On the quiz display there are also home buttons (back to initial appearance), back and next .

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The testing or testing phase is carried out after the completion of the assembly stage by running the application/program and checking for errors. At this stage, Blackbox testing and Whitebox testing are carried out. Blackbox testing is a testing method based on application details such as application appearance, functions in the application, and the suitability of the function flow in the application. Testing on Blackbox focuses more on the outer appearance (Interface). Meanwhile, Whitebox testing is carried out on software to check and analyze the program code for any errors or mistakes that may not be found when testing the system interface display or what is commonly called the Blackbox testing method.

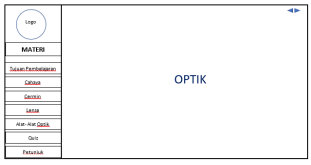
The data collection technique used in this study was a questionnaire or questionnaire, which was given to media experts and material experts using a Likert scale. Response questionnaires were also given to physics education students who took the IT-Based Educational Media Development Design course. Additionally, observations were conducted as part of the technique..

The instruments used for collecting data in this study were adapted from ISO 9126, which includes six characteristics: Functionality, Portability, Reliability, Efficiency, Learnability, and Usability.

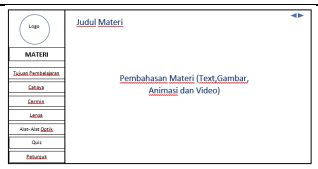
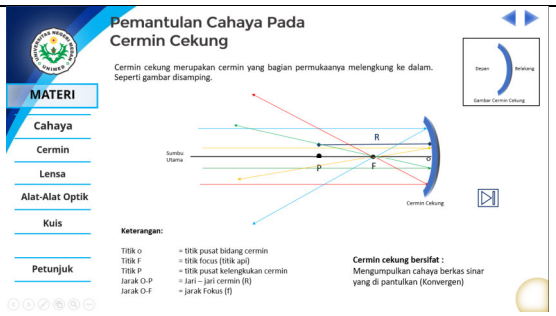
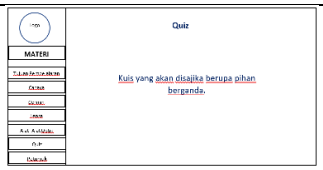
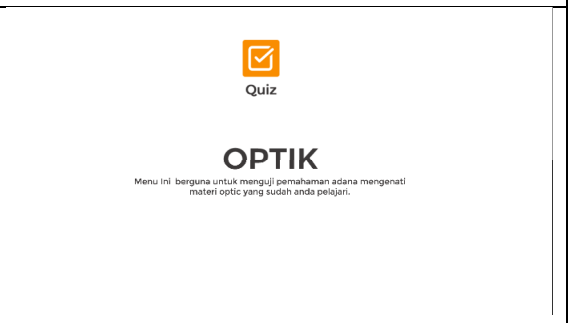
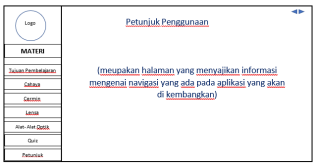
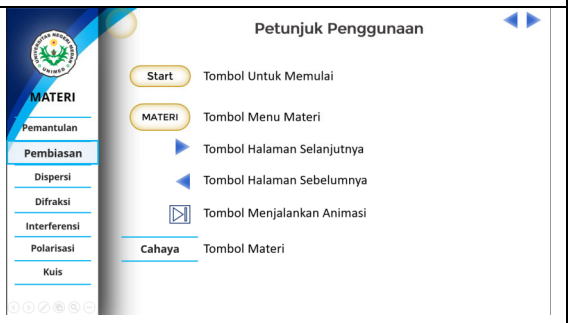
Result and discussion

As for the results from the study this is Application learning based on Android in the form of AILO- Phy . Following this description from the application that has made.

Table 2. Development results study

No	Visual	Information	Show Results
1		Initial View. The initial display is the first display when the learning media application is opened on the Smartphone . In this initial display there is the Medan State University logo, a welcome sentence to interactive physics learning and a Material button	
2		Initial Menu On the initial menu there are several menus that can be accessed according to user needs. The menu buttons available on the initial menu are: Light , Mirror , Lens , Optical Tools , Quiz and Hints .	

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3		In the material view there will be a title material and included look review established material _ from text , images , Simulation and Video .	
4		. In the quiz display there is a menu of multiple choice questions . The questions on this menu have been adapted to the material presented on the material menu. In the quiz display there are also home buttons (back to initial appearance), back , and next	
8		In this prompt, will explain how to use the application and the functions of the tools provided. In this guide display there is also a button to return to the initial display .	

a. Results of Expert Validation and Field Testing

Table 3. Results of expert validation and field testing

No	Description	Percentage Average	Criteria
1	Material Expert Validation Results	76.69 %	Worthy
2	Media Expert Validation Results	76.86%	Worthy
3	Trial Results Field	88.03 %	Very Good

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Conclusions

The development of the Ailo-Phy Learning Application (Android Based Interactive Learning Media for Physics) in Optical Materials was carried out based on procedures. The validation of the results of the Ailo-Phy Application was conducted by material experts, media experts, and users in the field. The Ailo-Phy learning application was declared feasible to continue with field testing based on the validation conducted. The assessment by material experts indicates that the Ailo-Phy application for optical materials is suitable and meets the standards of learning materials. According to the validation questionnaire, 76.69% of material experts responded that the optical material in the Ailo-Phy application is suitable for use because it contains material and delivery criteria that meet the standards for delivering messages to users.

The Ailo-Phy learning application was declared feasible based on the assessment by media experts with an average percentage of 76.86%, indicating that it meets the principles and criteria for developing learning media. The application was also tested in the field on 80 respondents, with an average percentage of 88.03% of respondents stating that it was very feasible. The application provides benefits such as easy-to-understand material presented in a systematic way with concepts, the ability for users to learn at their own pace, interesting animation and images to aid concept comprehension, and the ability to overcome limitations in conventional learning media, including distance and time constraints. The application also allows for a concise and repeatable description of events related to light and optics, enhancing clarity of understanding.

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Students' scientific argumentation on stationary and traveling wave material through EBM-assisted PJBL-STEM-FA

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Abstract. *Physics learning is evidence and experimental based learning that are communicated in scientific argumentation activities. Scientific argumentation is a form of student effort to create scientific knowledge in solving contextual problems. PjBL-STEM provides direct experience in solving contextual problems experienced by students. However, PjBL-STEM-FA assisted by Excel-Based Modeling (EBM) is still rare to improve students' scientific argumentation skills on traveling waves and stationary waves. The purpose of this study was to improve students' scientific argumentation skills through EBM-assisted PjBL-STEM-FA model. This research is mixed methods research with embedded experimental design type which was conducted on 29 high school students in Ende district, Indonesia. The research data was taken using 7 questions of scientific argumentation with a reliability of 0.679 (high category), observation and interviews. Students produce simple prototypes, namely earthquake detectors and wave antennas. The results showed that the EBM-assisted PjBL-STEM-FA model had an effect on students' scientific arguments and was supported by N-gain 0.209 (low category), effect size 3.59 (very strong category) and the highest level obtained by students is level 5. Students' scientific argumentation in the traveling wave sub-material higher than the stationary wave. In general, students still have difficulties in scientific argumentation, especially in the stationary wave submaterial. The difficulty of students in providing scientific argumentation is caused by 1) students' weaknesses in understanding the given wave representation, 2) the lack of students' conceptual understanding of particle motion on waves, and 3) students' inability to explain scientific facts and concepts into everyday language. Future research is expected to optimize learning with a multi-representation approach.*

Keywords: *PBL-STEM-FA, excel based modeling, wave*

Introduction

Scientific argumentation is one of the main components in learning physics [1]. Scientific argumentations can improve students' scientific literacy skills, develop critical thinking skills, and

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students' communication skills [2,3]. Scientific argumentations can improve students' abilities and understanding of events that occur in the surrounding environment [4]. However, the difficulty in building scientific argumentation from students' questions and ideas [5] and integrating them into learning [6] is a fundamental problem that is still rarely studied. Scientific argumentations include claims, evidence, the relationship between claims and evidence (warrants), quality and type of reasoning, rebuttal and claim limits [7]. The argument begins with a claim. Students make claims and use scientific argumentations to justify and prove claims that have been made [8]. Scientific argumentation begins with the existence of problems and arguments to find solutions to the problems encountered.

Important aspects of science learning include instructional learning that supports data-based reasoning and argument, data analysis and its application in real life [9]. Data-based argumentation (scientific argumentation) is one of students' thinking skills [8] which can develop students' scientific literacy skills [3]. Scientific argumentations can also be developed through learning based on the environment and social life [10]. Scientific argumentation can be seen as the ability of students to relate data and facts to scientific theories [11] or also the ability of students to construct new knowledge based on the data and facts found [1]. This learning aspect helps students understand the concept of science so that in the end students can achieve learning goals and the process of knowledge transfer can occur [9]. Scientific argumentations build students' social skills and social knowledge [12]. Scientific argumentations are used by students to build scientific knowledge [8] and in collaborative learning [13]. For this reason, students' scientific argumentations must be based on evidence and facts [14] found in learning. The data and facts found from several sources of knowledge [1] are then used by students in 2 forms of arguments, namely arguments from success and arguments from retention [15].

Research on scientific argumentation have been carried out such as ADI (Argumentation Driven Inquiry) based learning [16]. However, this learning is still oriented to the results of the practicum while students have not been able to construct their own knowledge gained in learning. Students' errors in interpreting mathematical equations often lead to student misconceptions [17]. Weaknesses in constructing information, facts and data through problem descriptions, the use of mathematical strategies and procedures in solving problems make scientific argumentation skills low [18] and students' understanding of concepts [19]. This means that science and mathematics abilities, and students' real experiences support students' understanding of wave material. This ability and real experience can be obtained by students through the experience of completing engineering product designs in PjBL-STEM and EBM learning. The experience of students involved in the engineering process is an advantage of the STEM approach so that students can practice their psychomotor aspects [20].

Another weakness that is still found in previous research on scientific argumentation is the lack of students' ability to represent the wave model [21–23] and student involvement in the learning model used [3,11]. Aspects of making wave representations and student involvement in learning are characteristics of collaborative learning. PjBL-STEM learning is collaborative learning [24] that combines investigation in the real world through discussion and scientific argumentation [25]. PjBL-STEM learning is oriented towards student discovery so that students' motivation, scientific argumentation and problem-solving increase [26]. However, EBM-assisted PjBL-STEM-FA is still rarely used in improving students' scientific argumentation skills on traveling waves and stationary waves.

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In learning physics, Ms. Excel was developed as a representation model [19], [27–31] in improving students' conceptual understanding. The use of excel as a representation model can reduce the occurrence of mathematical calculation errors [17]. Mathematical calculation errors made by students often reduce students' understanding of physics concepts [17]. This can lead to students' misconceptions about the concepts being taught. Excel-based modeling prioritizes continuous observation of students' conceptual understanding processes [32] which in conclusion can improve students' conceptual understanding [19]. Students who have a good understanding of concepts will be able to construct scientific argumentations based on data and facts.

Method

This research is mixed methods research with embedded experimental design type [33] on 29 class XI Catholic high school students in Ende, Indonesia who were selected using purposive sampling technique [34]. The research instrument used is 7 questions of scientific argumentation with a reliability of 0.679 (high category), observation sheets and interview guides. Before conducting the research, the researcher interviewed the physics teacher to explore the students' initial ability to argue. Then, students are given a pretest to determine the students' initial ability to provide scientific argumentations based on phenomena and the ability to provide arguments based on the representations contained in the questions. Furthermore, students were given research treatment and then ended with a posttest to find out how far the effect of EBM-assisted PjBL-STEM-FA on increasing students' scientific argumentation skills. During the provision of action in the form of PjBL-STEM-FA assisted by EBM, researchers collected data on the development of students' scientific argumentation skills through observation and giving FA. Students also make prototypes of earthquake detectors and wave antennas. After learning, the researcher conducted interviews with the students to obtain more in-depth information about the students' difficulties in providing scientific argumentations. Research data in the form of pretest and posttest values were analyzed using the Wilcoxon signed rank test, N-gain, and effect size [35]. Qualitative data in the form of interview and observation data were analyzed through data reduction, coding and interpretation [36].

Result and discussion

How EBM assisted PjBL-STEM-FA learning improves students' scientific argumentations?

The EBM-assisted PjBL-STEM-FA learning took place for 5 offline and online meetings due to the increasing covid-19 situation in Ende district. In the first 2 meetings, students studied the traveling wave material and produced a prototype of an earthquake detector as shown in Figure 1.a. In the next 3 meetings, students studied stationary wave material and produced a wave antenna as shown in Figure 1.b. EBM-assisted PjBL-STEM-FA learning is carried out using 7 important steps, namely identify problems and constraints, research, ideate, analyze ideas, build, test and refine, and communicate and reflect [20], [37]; while FA is oriented towards clear learning goals, discussion, giving feedback, group work and individual work [38]–[40]. The provision of EBM is intended as a teacher's assistance in understanding the spreadsheet-based concept of waves [19], [29].

At the beginning of the lesson, the teacher gives contextual problems that students often do in the form of questions and answers:

Teacher : What happens if you throw a stone in a pool of water?

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Student 1 : There will be waves that go up and down, sir.
Student 2 : Yes sir. The waves are circular.
Teacher : Does the wave carry energy with it?
Student 2 : No. Because the rock is supposed to have energy.
Student 3 : Yes sir. The stone fell from a height, sir. Therefore, stones have potential energy. While water does not have Sir.



Figure 1.a. Students' earthquake detector



Figure 1.b. Group of students making wave antenna

This shows that students are less sure of claims based on facts that occur through this phenomenon. As a result, the scientific argumentations put forward by students become weak. To strengthen students' understanding of waves, the teacher gives EBM as shown in Figure 2. By giving EBM, students are expected to be able to understand the concept of waves as particle motion and wave motion which also carries energy in it.

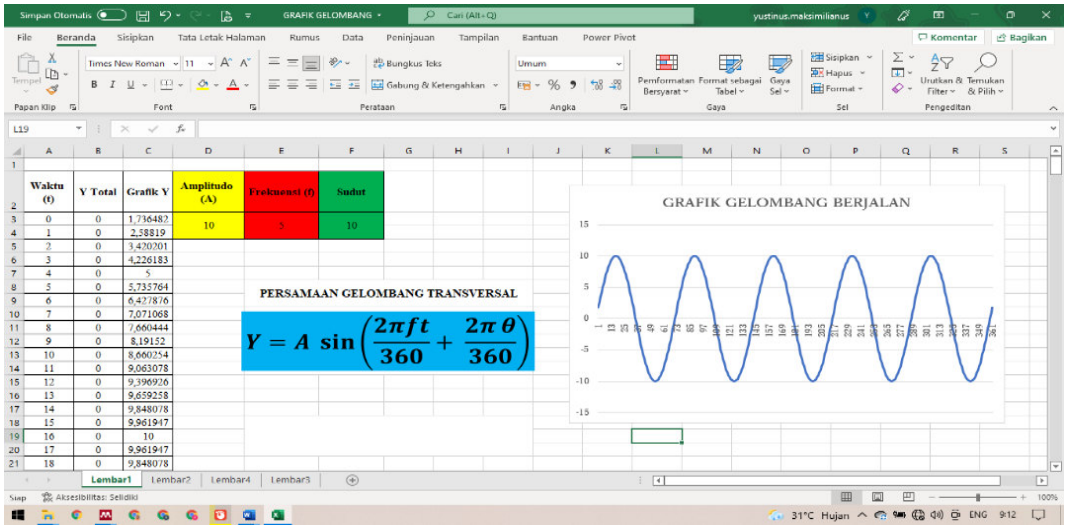


Figure 2. Traveling wave EBM

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Students then discuss contextual problem-solving ideas given by the teacher in groups. This discussion is intended so that students can determine the best idea by analyzing the possible strengths and weaknesses of each idea. The best idea selected by the student group is then made in the form of a prototype as a contextual problem-solving solution given by the teacher. The prototypes made by students were then tested for feasibility and given input in group presentation activities. Reporting the results of the student prototype in the form of a poster as shown in Figure 3.a and Figure 3.b.



(a) (b)

Figure 3. (a) Poster for earthquake detection equipment (SMART) (b) Poster for wave antenna (FRANDO)

Students' scientific argumentation of traveling wave and stationary wave

Normality test is used to determine whether the quantitative data is normally distributed or not. Normality test can be seen in Table 1.

Table 1. Normality test of scientific argumentation

Statistik	Shapiro-Wilk		
	Statistic	df	Sig.
Nilai PreTest AI	0,846	29	0,001
Nilai PostTest AI	0,941	29	0,107

Based on Table 1, the PreTest AI value data is not normally distributed, Sig. < 0.05 (0.001 < 0.05) while the PostTest AI value data has been normally distributed (0.107 > 0.05). One of the research data (AI pretest value) is not normally distributed, the next step is to perform a non-parametric statistical test, namely the Wilcoxon test. The Wilcoxon test was conducted to

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determine whether there was a difference in students' scientific argumentation abilities before and after giving the action in the form of PjBL-STEM-FA learning assisted by EBM. The data from the Wilcoxon test analysis can be seen in Table 2.

Table 2. Wilcoxon signed rank test results

	Pretest-Posttest
Z	-4,704[b]
Asymp. Sig. (2-tailed)	0,000

Based on Table 2, it can be concluded that there are differences in students' scientific argumentation abilities before and after giving the action in the form of the PjBL-STEM-FA learning model assisted by EBM. This means that the PjBL-STEM-FA learning model assisted by EBM has an effect on increasing students' scientific argumentations. To find out how big the difference in the ability of scientific argumentation is, the Normalized Gain Score Test is carried out. The research data shows that there is an increase in students' scientific argumentation ability of 0.209 (low category) as shown in Table 3. But PjBL-STEM-FA assisted by EBM has a strong influence on increasing students' scientific argumentation by 3.59 (very strong category) such as which can be seen in Table 4.

Tabel 3. N-gain score

Question Number (QN)		**N-Gain Score**	**Category**
Traveling Wave	QN 1	0,05	Low
	QN 3	0,21	Low
	QN 5	0,18	Low
	QN 6	0,92	High
Mean		0,318	Medium
Stationary Wave	QN 2	0,09	Low
	QN 4	0,06	Low
	QN 7	0,06	Low
Mean		0,073	Low
Min.		0,06	
Max		0,92	
Mean		0,209	Low

Tabel 4. Effect size score

Data	**N**	**Mean**	**SD**	**Effect Size**
PreTest	29	26,62	2,97	3,59
PostTest	29	41,93	5,55	

Students' scientific argumentation abilities in PjBL-STEM-FA learning assisted by EBM can be categorized into 2 categories according to the character of the material, namely students' scientific argumentations on the traveling wave sub-material and its application in life and students' scientific argumentations on the medium's influence on changes in stationary wave propagation speed. The first sub-material, traveling waves and their application in life, contains 4 questions, namely number 1, number 3, number 5, and number 6. The average scientific argumentation ability

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of students is still at level 2 by 40%. The lowest level of argumentation is at level 1 (28%) and the highest level of argumentation is at level 5 (24%).

The weakness of students in providing scientific argumentations on the sub-material of traveling waves and their application in life is caused by 3 things, namely, 1) the inability of students to understand the given wave representation, 2) the weakness of understanding the concept of particle motion in waves, and 3) the inability of students to discuss facts. and scientific concepts into everyday language. Students who understand the representation given will more easily understand the problem and be able to provide scientific argumentations. The ability of students to understand the representation of traveling waves is the main key in understanding questions number 1 and 5. The researcher found that students who were able to provide data-based scientific argumentations, warrants or simple backings, the ability to understand the concept was based on students' understanding of the representation of traveling waves contained in the text. question. This is in line with the findings of Sari et al. [41], namely students' argumentation skills increased after being given contextual-multi-representation learning. Interviews with AA students also confirmed that the influence of walking wave representation ability greatly helped AA students in providing their scientific argumentations.

The weakness of students' scientific argumentations is also influenced by the weak understanding of students' concepts and the inability of students to discuss scientific facts and concepts in everyday language. Weak understanding of students' concepts causes students to be unable to formulate scientific facts and concepts into scientific argumentations. This finding is in line with the findings of Okumus & Unal [42], namely that students have difficulty making scientific argumentations because they are not used to being involved in giving arguments in learning activities. This finding is also consistent with the results of interviews with students who have difficulty compiling their scientific argumentations. Some students have difficulty in arguing because the learning that has been obtained so far has not involved scientific argumentation to construct knowledge.

Weak understanding of students' concepts causes students to be less confident in giving arguments to the problems given. Lee et al. [6] calls it the uncertainty of the response given by students to the argumentative questions given. The uncertainty of this response resulted in the scientific argumentation ability of students in the traveling wave sub-material on average at level 2. As a result, some students were only able to present arguments with one simple warrant or backing and students who were classified as "smart" were able to argue by providing data, claims, warranties, and simple backing. Most of students have not been able to give rebuttal well. This finding is in line with Ho et al. [8], namely students still have difficulty in giving rebuttal to their own arguments. The importance of students' beliefs in providing scientific argumentations [43] is one of the key factors for learning success.

In the sub-material of the influence of the medium on changes in the speed of stationary wave propagation, the weakness of students in arguing is influenced by 2 things, namely misconceptions and students' weak understanding of concepts. There are 3 scientific argumentation questions, namely number 2, number 4, and number 7. The highest level that can be achieved by students is level 3 (5%) with the average scientific argumentation ability of students in this sub-material at level 1 (53%). The ability of students' scientific argumentation in this sub-material is low. This is because students often misapply concepts (misconceptions) in building their scientific argumentations. Students' misconceptions occur because of the weak understanding of students' concepts on stationary wave material, weak interpretation of images/representations

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given in the problem and students' weak ability to understand the relationship between physical quantities on stationary waves. These 3 things lead to misconceptions that have an impact on the weakness of students' scientific argumentation skills. This is consistent with the findings of Istiqomah et al. [44], namely students' misconceptions about the mechanical wave material due to the inability of students to understand concepts and symbols.

Weak understanding of students' concepts in the sub-material of the influence of the medium on changes in the speed of wave propagation causes misconceptions to arise or understand the concept with misconceptions. This factor causes students to have difficulty constructing scientific argumentations and building scientific argumentations using misconceptions. The findings of this study are in line with the research of Yana et al. [45] namely the understanding of the concept of most students on wave material is based on misconceptions. Based on interviews with students, the researcher concluded that the low level of students' scientific argumentation due to misconceptions was caused by the lack of learning based on developing scientific argumentation skills. The results of this interview are identical with the findings of Suganda et al. [46] who found that the low ability of students' scientific argumentation was due to the lack of implementation of learning based on strengthening students' scientific argumentation.

The PjBL-STEM-FA learning model assisted by EBM is a learning that can increase scientific knowledge and student responses [47]. The role of formative assessment in PjBL-STEM learning is also very crucial. Formative assessment becomes a model for collaborative learning activities [48]. The involvement of students in the learning process is the key in building and developing students' argumentation skills. The involvement of students in group discussions helps students in developing students' argumentation skills [49]. The pattern of students' argumentation development can be seen from 5 activities [50], namely: 1) asking questions, 2) examining raw data, 3) making claims, 4) using data as evidence to support or test claims, and 5) using reasoning to argue. These 5 activities are merged into the PjBL-STEM model stage with formative assessment and EBM, especially in the research, ideate, analyze ideas, build, and test, and refine stages.

The application of the PjBL-STEM-FA model assisted by EBM can improve students' scientific argumentation skills. Scientific argumentations develop in line with the development of students' conceptual understanding [51]. Good critical thinking skills also support the improvement of students' scientific argumentation skills [52]. Concept understanding and critical thinking [53] support students' scientific argumentation skills [52] in EBM-assisted PjBL-STEM-FA learning. Through discussion activities [52] and EBM as a representation model [54]–[56], scientific argumentation skills are formed and developed. That is, the application of PjBL-STEM-FA assisted by EBM to scientific argumentations is recommended to be widely practiced.

Conclusion

PjBL-STEM-FA learning assisted by EBM can improve students' scientific argumentation skills on the material of traveling waves and stationary waves. The average increase in scientific argumentation skills is at level 2 with an N-gain value of 0.209 (low category). PjBL-STEM-FA learning assisted by EBM also has a strong influence on increasing students' scientific argumentation skills with an effect size value of 3.59 (very strong category). The highest increase in students' scientific argumentation skills is in the traveling wave material. Students' difficulties in constructing scientific argumentations are caused by 1) students' inability to understand the given wave representation, 2) weak understanding of the concept of particle motion in waves, and

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3) students' inability to explain scientific facts and concepts into everyday language. Future research is expected to further optimize multi-representation learning.

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Feasibility test of whiteboard animation based learning multimedia on work and energy material

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Abstract. *Technological developments have encouraged the development of learning systems, one of them is using multimedia. Optimal use of multimedia in the learning process can encourage the quality enhancement of learning so that it becomes one of the essential factors for student learning outcomes. This study aims to determine the feasibility of learning multimedia based on whiteboard animation on work and energy materials. This research is a type of research and development using the 4D development model which consists of 1) Define; 2) Design; 3) Development; and 4) Disseminate. A learning multimedia product based on whiteboard animation has been produced on work and energy materials. The due diligence assessment of the resulting learning multimedia products is carried out by two experts, namely material experts and media experts. The results of the material aspect feasibility test for learning multimedia products based on whiteboard animation on work and energy materials obtained an average of 85.33% (very feasible). While the results of the media aspect feasibility test for learning multimedia products based on whiteboard animation on work and energy materials obtained an average of 83% (very feasible). Thus, it can be concluded that learning multimedia based on whiteboard animation on work and energy material is very suitable for learning physics in high school.*

Keywords: *multimedia, learning, whiteboard animation, physics, work and energy*

Introduction

Technology has become one of the indicators of change and development of the times and has a major influence on human life. Technological developments have driven various changes and

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developments in various sectors, one of which is the education sector [1]. Education is currently being strived to be able to develop along with technological developments, namely by utilizing the potential of technology in various learning activities. Besides that, conventional learning methods and even the applications used today are still not enough because of the digital revolution [2]. The digital revolution has transformed various learning activities by optimizing information and communication system technology to continuously improve the quality of learning [3].

Integrating technology in the learning process is one of the potentials that has been continuously developed by various experts and researchers to date in order to improve the quality of Human Resources (HR). This is due to the large potential of technology for various opportunities that can be obtained in the learning process, such as 1) more optimal visualization of learning concepts and materials; 2) ease of acquiring and developing knowledge; 3) ease of accessing and exploring various learning resources; 4) can be used anytime and anywhere, and 5) provide opportunities for students to integrate some knowledge and develop their abilities [4-6]. Therefore, the level of technology utilization in learning is one of the factors that can determine the quality of learning in the classroom, including learning science [7]. This is in line with the quality of 21st-century learning which encourages the improvement of various essential skills through optimizing the use of technology in learning [8].

Changes in the education sector have reformed the changing objectives of preparing students to solve complex problems associated with a competitive environment and rapid technological developments. Learning in the 21st century is digital-based learning and based on independent thoughts. Therefore, the learning system must be equipped with the development of higher-order thinking skills and other essential competencies in students [9]. Higher thinking skills include critical, logical, metacognition, creative, and reflective thinking [10].

Meanwhile, one of the subjects that require the development of higher-order thinking skills and critical thinking in physics. Developing students' high-order thinking skills in learning physics can help students understand physics material optimally. This is because physics is a material that has high difficulty and is complex. In addition, some physics material is also abstract, so it requires various learning resource facilities that can encourage student understanding, one of which is the material on work and energy. Abstract characteristics of physics subjects can result in low learning motivation and student achievement [11]. The current learning system continues to encourage students to be more active in the teaching and learning process. Besides that, learning motivation and understanding of concepts that are less than optimal will affect the level of student activity in class [12]. The low level of student activity indicates that students are not motivated in learning physics. In addition, low student activity results in the learning process becoming teacher-centered. Teacher-centered learning is currently irrelevant and unable to motivate students to improve various essential skills, especially critical thinking and problem-solving skills. Besides that, students also often have difficulty learning physics material independently [13]. Learning in class alone is not enough, students need to optimize their understanding independently to obtain optimal learning results. Therefore, learning resources are needed that can help students learn well, one of which is by using Multimedia Whiteboard Animation.

Whiteboard Animation is an animated video that can explain a theory or concept by adding hand gestures to draw on a whiteboard. Depictions made using Whiteboard Animation can be synchronized with audio which communicates theoretical content clearly [14]. The display on Whiteboard Animation can be designed to contain an explanation of the material in the form of text, images, or illustrations so that the explanation of the material becomes more interesting. This

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has the potential to increase student motivation [15]. Various research results related to the development of Whiteboard Animation multimedia on physics material obtained the result that the developed multimedia was stated to be valid and practical, so it was very feasible and effective to use [16-17]. Therefore, the development of Whiteboard Animation also has the potential for work and energy materials. In addition, the use of Whiteboard Animation in learning material on work and energy provides an opportunity for students to repeat material and study the media independently.

Work and energy are physics materials whose phenomena are often found in everyday life. Work and energy are quite complex physical materials, the complexity of which can be seen from the relationships between various concepts. This is because physics is a science that essentially combines facts, concepts, theories, and laws in solving problems or phenomena [18]. Work and energy are physical materials that are contextual or application-based [19]. However, based on the results of various previous studies, it was found that work and energy materials still tend to have quite large misconceptions [20-22]. Therefore, the explanation of work and energy material needs to be optimized through the visualization of various phenomena that can be explained or formulated using the theory of work and energy. Therefore, the use of Whiteboard Animation has the potential to be used as a learning medium, so that it can help students understand the concepts and applications of work and energy materials.

Based on the problems of students' understanding of work and energy material and the potential of technology integration in learning, it is necessary to develop multimedia to increase student understanding. This study aims to develop learning multimedia on work and energy materials by using Whiteboard Animation. This study also aims to test the feasibility of the developed learning multimedia. Thus, the developed multimedia can be used to increase students' understanding of work and energy material, so that it can also improve student learning outcomes.

Methodology

This study uses the Research and Development (R&D) method with a 4D development model consisting of Define, Design, Develop, and Disseminate [23]. This research is conducted only up to the product feasibility test stage to determine the level of product validity based on the assessment of material experts and media experts. Multimedia validity is tested to determine the feasibility level of the developed product. Multimedia that is ready and suitable for use is multimedia that has been declared valid based on the material and media. The developed multimedia is validated by material experts and media experts with 1 expert lecturer each. Meanwhile, product development is carried out based on the stages in Figure 1.

The defining stage is carried out to find out the current physics learning problems. This stage is carried out through the study of various types of literature and observation. This stage is also carried out to analyze the needs of product development to be developed so that it can overcome the problems found. Next is the design stage. The design stage is carried out by designing product content and determining product validity with the help of material experts and media experts. Research continued with the development stage. The development stage includes the analysis and determination of the components needed for the explanation of work and energy materials. In addition, this stage also includes designing and developing designs from Whiteboard Animation on work and energy materials. The research phase ends with the due diligence stage by

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material experts and media experts. The valid product is then ready to be used and distributed to schools.

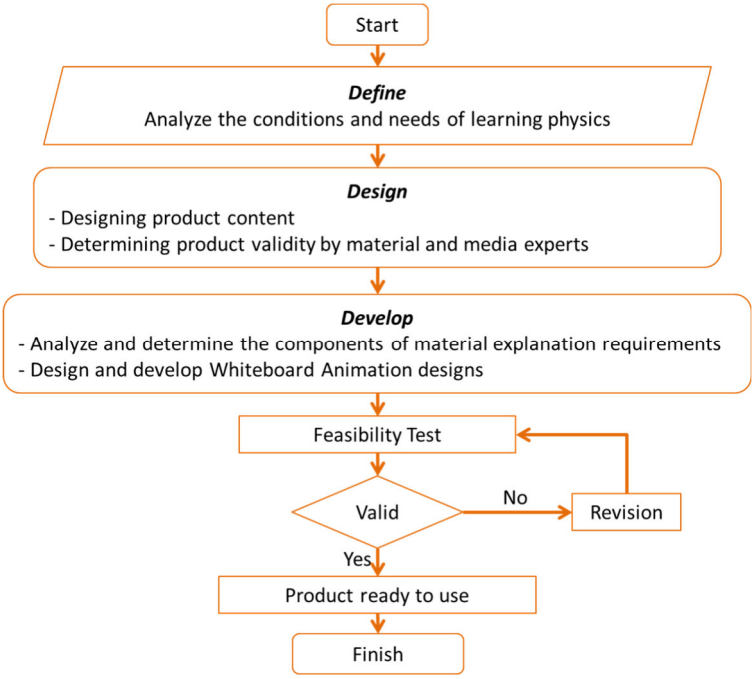


Figure 1. Research and development design with model 4D

This study uses an instrument in the form of a questionnaire of material experts and media experts to determine the level of product validity. Meanwhile, this research is mixed method research which is a combination of qualitative research and quantitative research [24]. Therefore, the data obtained from the research results were analyzed using qualitative and quantitative data analysis techniques. The validation questionnaire is prepared using a Likert scale. Input from experts is analyzed qualitatively, while the results of the questionnaire tabulation were analyzed quantitatively.

The results of the validation test for material experts and media experts were analyzed by calculating the average value for each aspect of the assessment using equation (1). Meanwhile, the results of the analysis from the expert validation questionnaire are then interpreted according to Table 1.

$$Ps = \frac{\sum S_k}{n} \; x \; 100 \; \% \qquad (1)$$

Description:
Ps = Score percentage
$\sum S_k$ = Score item of k aspect
n = Indicator quantity of k aspect

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Table 1. The interpretation of material and media expert result

The Feasibility Percentage	The Feasibility Classification	Description
81 – 100 %	Very feasible	Can be used without revision
61 – 80 %	Feasible	Can be used without revision
41 – 60 %	Adequate feasible	Can be used with little revision
21 - 40 %	Less feasible	Can be used with many revision
0 – 20 %	Not feasible	Can not be used with total revision

Result and discussion

Whiteboard Animation-based multimedia on work and energy materials is developed based on learning needs, namely to increase student learning motivation and understanding of concepts. The material in Whiteboard Animation is arranged based on core competencies, basic competencies, and learning indicators. Multimedia that has been developed is validated by material experts and media experts using a questionnaire. Meanwhile, the assessment elements in the questionnaire include aspects of content feasibility, language, and presentation aspects. The validation that has been carried out by material experts on the developed multimedia can be seen in Table 2.

Table 2. The result of material expert validation

Assessment Aspect	Indicator	Score	The Rate of Each Indicators	Category
Contents feasibility	1. The suitability of material with core of competency, fundamental of competency, and learning indicators	4	87%	Very feasible
	2. The accuracy of concept	4		
	3. The completeness of material	5		
	4. The accuracy of notations and symbols	4		
	5. The accuracy of terms	5		
	6. The updating of material	4		
Linguistic feasibility	1. Communicative	4	85%	Very feasible
	2. The accuracy of linguistic	5		
	3. The simplicity of linguistic	4		
	4. The quality of explanation	4		
Presentation feasibility	1. The perceptible presentation of text and picture	4	84%	Very feasible
	2. The complementarity of presentation	4		
	3. The systematic presentation	4		
	4. The completeness of presentation	4		
	5. Consistency of using terms and symbols	5		

The data tabulation in Table 2 shows that the content of the material arranged in multimedia is in the very proper category, which is 87%. This shows that the material described in the product meets the provisions of core competencies, basic competencies, and material indicators. In

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addition, the concepts explained in multimedia have high accuracy, so that the truth can be accounted for and in accordance with the results of research by experts. In addition, the material contained in the product is very complete, so it is able to explain work and energy material clearly. A complete explanation of a material is one of the essential factors to support student understanding. Besides that, notations and symbols in multimedia are arranged according to accuracy. The terms used in multimedia are accurate and explained, thus providing insight to students.

Based on the analysis of the data in Table 2, it was also found that the developed multimedia was prepared according to very appropriate language rules, with a percentage of 90%. The use of language used in multimedia can affect the level of understanding of users so linguistic elements are one of the essential factors that need attention. In the developed Multimedia Whiteboard Animation, the language used is communicative, precise, and simple, so it makes it easy for users to understand the material. In addition, the quality of explanations on Whiteboard Animation is very good. The use of appropriate language will also affect student learning motivation.

Besides that, the aspect of presentation in multimedia also received a very decent category, namely 84%. This percentage shows that the explanation elements in multimedia are presented very well. Meanwhile, presentation aspects include text and image presentation, presentation support, presentation systematics, completeness of presentation, and consistency in the use of terms and symbols.

Based on the assessment of the feasibility of the content, language, and presentation aspects, the average percentage value of the results of the validation test by material experts is 85.33%. This shows that all aspects of the material validation test have met the standard, namely the very feasible category. Thus, the material presented can be used by students to learn and understand.

The developed multimedia is also validated by media experts to determine the level of product validity so that it is ready for use by students. Media validation testing is assessed based on aspects of appearance accuracy, aesthetics, efficiency, and durability. Meanwhile, the results of the validation test analysis by media experts can be seen in Table 3.

Table 3. The result of media validation

Assessment Aspect	Indicator	Score	The Rate of Indicators	Category
Display accuracy aspect	1. The quality of picture	4	83%	Very Feasible
	2. The quality of sound	5		
	3. The quality of lighting	4		
	4. Text legibility	4		
	5. Text layout	4		
	6. Consistency of font, figure, space, and punctuation mark	4		
	7. Material presentation time	4		
Aesthetics	1. Media attraction	4	80%	Very Feasible
	2. Harmonization of choosing colors and figures	4		
	3. Combination of used colors	4		
Efficiency	1. Simplicity of utilization	4	80%	Very Feasible
	2. Simplicity of storage	4		

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Assessment Aspect	Indicator	Score	The Rate of Indicators	Category
	3. Does not need a certain special action for using	4		
Endurance	1. Can be used in long period	5	90%	Very Feasible
	2. Not easily broken	4		

The data in Table 3 shows that multimedia based on Whiteboard Animation on work and energy materials is in the very proper category, with a percentage of 83%. The developed multimedia is composed to contain images, sound, and lighting with very good quality. In addition, the text has good legibility. The layout of text on multimedia can also be arranged neatly. In addition, the developed multimedia has proportional consistency of letters, images, spacing, and punctuation. The time for presenting material is also efficient so that learning becomes more optimal.

The developed multimedia also contains a very decent aesthetic with a percentage of 80%. Whiteboard Animation with work and energy materials is arranged attractively, namely by using attractive color combinations, as well as the selection of image colors and text in harmony. Therefore, the use of the right color supports the process of seeing or reading text on the screen. Appropriate and attractive aesthetics will increase students' learning motivation towards physics lessons, especially in the material of work and energy.

Besides that, the product being developed also has a very decent efficiency, namely with a percentage of 80%. The developed multimedia can be accessed, used, and stored very easily. In addition, the use of media does not require special treatment. Therefore, the product developed is very feasible and practical for use by students.

The results of data analysis in Table 3 also show that the developed multimedia has very good resilience. This is because multimedia can be used for a long time, and is not easily damaged. This is one of the advantages of using Whiteboard Animation, namely its use is flexible to time and place. Therefore, the advantages possessed by these products make it easy for students to learn the material with maximum effort and energy.

Based on data analysis on the aspects of display accuracy, aesthetics, efficiency, and durability, it can be generalized that every aspect is very feasible. Meanwhile, the average value of the aspects of the media elements is 83%. Therefore, Whiteboard Animation-based multimedia is very suitable to be used to explain work and energy materials. Optimal media quality will optimize student learning motivation.

The results of the analysis of material and media expert validation data show that the product developed is very feasible to be used to support the learning process. The use of Whiteboard Animation in physics lessons is one of the right solutions to reduce students' misconceptions. This is because Whiteboard Animation can visualize physics concepts. Visualization of physics concepts is one of the elements of learning activities that need to be optimized, to provide concrete understanding to students. Optimal student understanding can improve student learning outcomes.

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Conclusion

Optimizing the use of technology in the learning process is the right solution to overcome problems of understanding concepts and student learning motivation. In addition, the use of technology also provides more optimal, independent, and flexible learning opportunities. The developed Whiteboard Animation-based Multimedia obtained a very decent category in both material and media elements. Material elements get a percentage of 85.33%, with content feasibility aspects of 87%, linguistic feasibility aspects of 85%, and presentation feasibility aspects of 84%. Meanwhile, the media element obtained a percentage of 83%, with an accuracy aspect of 83% display, an aesthetic aspect of 80%, an efficiency aspect of 80%, and a durability aspect of 90%. Thus, Whiteboard Animation-based multimedia on work and energy material is very feasible and effective to use in the learning process.

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Building student's critical thinking skill with stem integrated problem based learning model through hybrid learning assisted by formative assessment on heat and temperature topic in the covid-19 pandemic era

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Abstract. *Critical thinking skill (CTS) is one of the four main skills in 21st century learning. CTS is needed in identifying problems and making decisions through appropriate physics concepts, but on heat and temperature topics students still have not mastered it optimally. This study aims to improve the CTS of high school students with a STEM integrated Problem Based Learning model through hybrid learning assisted by Formative Assessment (PBL-STEM-FA-HB) on heat and temperature topic. This embedded experimental design research uses a critical thinking skill test instrument with a reliability of 0.890, observation sheets, field notes, and interview guides on 33 students of class XI high school in Jember, Indonesia. The quantitative data of this study were analyzed by paired t-test, N-gain, and d-effect size, while the qualitative data were analyzed by means of reduction, coding, description and interpretation. The results showed that PBL-STEM-FA-HB learning was able to significantly increase student's CTS, with the N-gain and d-effect size being 0.71 (high category) and 6.68 (very strong category). Improvement based on CTS indicators starting from high to low, respectively, argument analysis, hypothesis testing, problem solving and decision making, likelihood and uncertainly analysis, and reasoning; Meanwhile, based on sub-materials, respectively, the influence of heat on changes in temperature or shape of objects, temperature and expansion, and heat transfer. Changes in CTS occurred in 58% of students from less to good. It is necessary to have the innovation of adding an "Art" element to become a STEAM approach in future research, and PBL-STEAM-AF learning needs to be carried out face-to-face.*

Keywords: PBL-STEM-FA-HB, critical thinking skill, heat and temperature topic

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Introduction

Heat and temperature are important materials in physics with various everyday uses such as the use of expansion in railroad connections, electrical wiring, and other life applications so it is important for students to study this material to make it easier to solve everyday problems through scientific concepts. , mathematical equations, and technology [1]. The importance of heat and temperature material demands student understanding, but in reality the results obtained by students on this topic are still less than optimal. Puspendik data related to the results of the National Examination in Indonesia for the high school level in the 2018/2019 academic year shows that the level of understanding of thermodynamics which includes heat and temperature material is only 46.58% and is included in the lowest order among other physics materials such as mechanics, waves and optics, as well as modern physics [2]. This is due to the difficulty of students in understanding the material, especially the sub-material of heat transfer due to its too abstract nature to study [3-7]. Students think that particles also move along with energy when conduction events occur [8]. In the convection process, students think that events involving heat and air energy are included in the radiation heat transfer process [9]. While in the radiation process, students think that color has no effect on the radiation process [10]. Understanding of heat and temperature material that is not optimal will affect students' critical thinking skills [1,11,12].

Previous research has been carried out to overcome the not yet optimal students' critical thinking skills on heat and temperature material with the conclusion that students still have difficulty in solving heat and temperature problems [12,13]. Suggestions from previous research include applying learning based on contextual problems by paying attention to psychomotor aspects as well as students' cognitive and affective aspects [11,14], applying appropriate learning methods in the current pandemic era [15,16], and process assessment is needed in developing students' critical thinking skills [17].

Problem based learning (PBL) is real problem-oriented learning that not only emphasizes cognitive and affective aspects, but also pays attention to students' psychomotor aspects [18]. Students will collaborate to solve contextual problems through higher-order thinking processes in the PBL process [11]. Therefore, PBL becomes important in improving students' critical thinking skills. Previous research stated that PBL was able to have a positive influence on students' critical thinking skills on heat and temperature material [19-21]. However, PBL has not measured in depth the extent to which the critical thinking ability indicators can be achieved by students on heat and temperature material [11]. However, with the advantages of STEM through the integration of the four STEM disciplines, it is able to provide opportunities to measure more deeply the indicators of students' critical thinking skills on heat and temperature material [23,24]. Therefore PBL is ideal if integrated with STEM.

In addition, PBL has limitations in monitoring student learning progress during online learning which causes teacher delivery to be less than optimal and has an impact on students' low critical thinking skills [16]. However, through hybrid learning, it is able to combine many forms of online learning modalities so as to optimize students' critical thinking skills when learning online, especially in the pandemic era [15,16,25,26]. Therefore, PBL is ideal when combined with hybrid learning as a learning method in the Covid-19 pandemic era.

Another limitation of PBL is that PBL only measures the end result of the learning process without assessing it in a structured manner related to the development of students' learning experiences during the learning process [27]. However, with the formative assessment, it is able to assess in a structured manner with rubrics related to student learning development during the

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learning process [17,28]. Therefore, PBL is ideal when combined with formative assessment as an assessment of the learning process. Thus, a combination of solutions from STEM-based PBL through hybrid learning accompanied by formative assessment (PBL-STEM-FA-HB)This is a strong reason for researchers to carry out this research in the era of the Covid-19 pandemic. In addition, research using learningPBL-STEM-FA-HBit is still rarely practiced, especially by adjusting learning in the pandemic era on heat and temperature material. Therefore, the purpose of this study is to improve the critical thinking skills of high school students with STEM-based problem based learning models through hybrid learning accompanied by formative assessments of heat and temperature topic.

Method

This study uses a mixed method of embedded experimental design with the subject of 33 students of class XI senior high school in Jember, Indonesia. Research subjects were selected through purposive sampling technique. The instrument in this study was a 10-item critical thinking test in the form of an essay with each test item representing an indicator of critical thinking with a reliability of 0.890 (very high category), an interview guide, and an observation sheet. The study begins with a pretest, then treatment, and ends with a posttest. Before the pretest, the researcher conducted interviews related to the students' initial understanding and habits of the learning process carried out at school. The results of the pretest provide information related to students' initial critical thinking skills when completing the test before being given treatment. Furthermore, interviews were conducted to find out the basic thinking of students towards the answers written during the pretest. The next stage is giving treatment in the form of a modelPBL-STEM-FA-HB. During the action treatment, the researcher collected data in the form of field notes from the formative assessment rubrics and observations. At the end of the lesson, a posttest was conducted to analyze students' critical thinking skills after giving treatment, then interviews to obtain more in-depth information regarding the reasons students answered each question and the difficulties experienced by students in studying heat and temperature. Pre-posttest quantitative data were analyzed by independent t-test, N-gain, and effect size. Qualitative data from interviews and observations were analyzed through data reduction, coding, and interpretation.

Result and discussion

Learning of PBL-STEM-FA-HB

PBL-STEM-FA learning was carried out for 5 meetings through hybrid online learning. PBL-STEM learning is oriented towards critical thinking processes in solving problems by integrating 4 STEM components into 5 stages of PBL, namely student orientation to problems, organizing students to seek information, independent and group investigations, developing and presenting work, as well as analyzing and evaluating problem solving process [29]; while the FA strategy includes clear learning objectives, discussion, providing feedback, student involvement and individual work [9,30]. The HB method in this study is a combination of synchronous, asynchronous, and self-paced asynchronous online learning.

The first meeting, students were given learning objectives to be achieved in PBL-STEM-FA-HB learning. In the first stage, namely the orientation of students to the problem, students are given contextual problems related to temperature and expansion in the form of a house fire problem that cannot be detected quickly by the owner of the house so that the fire quickly spreads and burns

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the entire house. The involvement of students in digging up information related to contextual problems is contained in the following question and answer quote:

Teacher : Berdasarkan cuplikan berita terkait kebaran rumah yang telah ditayangkan, bagaimana cara kalian mengetahui dan menyadari secara cepat terjadinya percikan api sehingga mengantisipasi terjadinya kebakaran?
Student 1 : Dari teriakan warga diluar rumah Pak.
Student 2 : Iya Pak. Biasanya selang beberapa menit setelah ada asap, banyak warga yang berdatangan dan berteriak memberitau pemilik rumah Pak.
Teacher : Mungkin ada jawaban lain?
Student 4 : Dari bau asap Pak.
Student 5 : O benar Pak. Biasanya dari bau asap sudah bisa diketahui Pak.

It appears that when a fire occurs, students are not able to anticipate a fire. So that the teacher explores information more deeply through discussions at the stage of organizing students to find information related to how students can immediately detect sparks as an effort to anticipate fires. Some students suggested the need for a tool to detect and give a warning sign if there were sparks from a fire event.

Students then carry out investigations through the process of temperature and expansion experiments to find prototype design ideas for contextual problems raised at the stage of helping independent and group investigations. Design ideas are then put forward and their strengths and weaknesses are analyzed, each idea is then selected and discussed with the group and the prototypes that have been made are then tested for feasibility. This feasibility test involves all students in the presentation activities of each group at the stage of developing and presenting the work. In the final stage, students are given reinforcement of the overall results of problem solving related to temperature and expansion and provide feedback on student product results at the stage of analyzing and evaluating the problem solving process. The results of group work through presentations and making fire alarm posters as shown in Figure 1.a.

At the last meeting, during the first stage, namely student orientation to problems, students were given contextual problems related to heat transfer in the form of extreme heat events that occurred until at night, resulting in many people overheating in the house. The involvement of students in digging up information related to contextual problems is contained in the following question and answer quote:

Teacher : Berdasarkan cuplikan berita terkait suhu panas ekstrim yang terjadi, bagaimana cara kalian mengatasi terjadinya suhu panas ekstrim?
Student 1 : Dengan mengurangi polusi udara yang bisa menimbulkan global warming Pak.
Teacher : Mungkin ada jawaban lain?
Student 2 : Dengan cara mendinginkan bagian tubuh Pak.
Teacher : Dengan cara apa untuk mendinginkannya?
Student 2 : Dengan cara mandi Pak.
Student 3 : Benar Pak. Karena setelah mandi badan kita menjadi segar dan tidak kepanasan lagi Pak.

It appears that when an extreme heat event occurs, students are not able to anticipate the occurrence of extreme heat. So that the teacher explores more in-depth information, with students being asked to discuss at the stage of organizing students to find information related to how

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students can provide solutions to the extreme heat. Some students suggested the need for an air conditioning system to cope with extreme heat events.

Students then carry out an investigation through the process of heat transfer experiments to find prototype design ideas that are suitable for the contextual problems raised at the stage of assisting independent and group investigations. Design ideas are then put forward and analyzed for their weaknesses and strengths, each idea is then selected and discussed with the group and the prototypes that have been made are then tested for feasibility. This feasibility test involves all students in the presentation activities of each group at the stage of developing and presenting the work. In the final stage, students are given overall reinforcement of the results of solving heat transfer problems and provide feedback on student product results at the stage of analyzing and evaluating the problem solving process. The results of group work through presentation activities and making miniature posters of the air conditioning system as shown in Figure 1.b.



(a) (b)

Figure 1. (a) Poster of Fire Detection Equipment (Fire Alarm) (b) Poster of Air Conditioner

Students' critical thinking ability on heat and temperature material

The result data in this study in the form of pretest and posttest scores of critical thinking are presented in Table 1, while the results of the normality test are in Table 2.

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Table 1. Descriptive statistic of critical thinking skill tests

Type of Test	N	Mean	SD
Pretest	33	25,30	6,75
Posttest	33	78,03	8,88

Table 2. Normality test

Type of Test	Sig.	Data Distribution
Pretest	0,074	Normal
Posttest	0,336	Normal

In Table 1, the average posttest score (78.03) is greater than the pretest score (25.30). In Table 2 shows that the results of the normality test using Shapiro-Wilk for the pretest and posttest data are normally distributed with the pretest and posttest significance values of 0.074 and 0.336 which are greater than the alpha value of 0.05. It appears that the data normality test requirements have been met so that it can be continued with the paired sample t test to analyze the differences in students' critical thinking abilities between the pretest and posttest, the N-gain test to determine the increase in students' critical thinking skills, and the effect size calculation to determine the magnitude of the effect of PBL. STEM-based through Hybrid Learning accompanied by Formative Assessment of critical thinking skills, all of which are presented in table 3.

Table 3. Paired sample t test, n-gain, and effect size

Statistic	Score	Category
Asymp. Sig. (2-tailed)	0,000	Significant differences
(*Paired Sample t Test*)		*Posttest > Pretest*
N-Gain	0,71	High
Cohen's d-effect size	6,68	Very Strong Effect

In Table 3, the results of the paired sample t test show that the significance level value is 0.000 which means that students' critical thinking scores before being taught and after being taughtPBL-STEM-FA-HBthere is a significant difference, where students' critical thinking skills after being taughtPBL-STEM-FA-HBhigher than before teaching. The effect size value of students' critical thinking skills was obtained at 6.68 which indicates that PBL-STEM-FA-HB has a very strong effect on students' critical thinking skills. In general, the N-gain value is 0.71 which indicates that the increase in students' critical thinking skills is in the high category. The N-gain value of each critical thinking indicator is presented in the bar chart in Figure 1.

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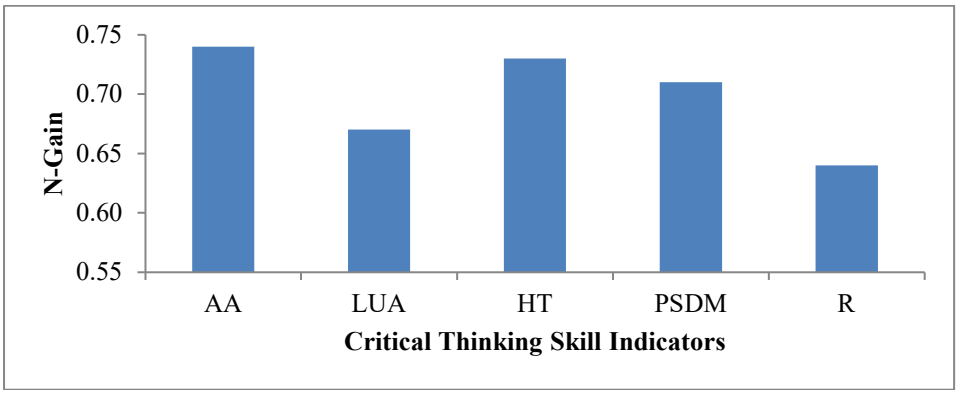


Figure 2. N-gain result by critical thinking skill indicators (AA: Argument Analysis, LUA: Likelihood and Uncertainly Analysis, HT: Hypothesis Testing, PSDM: Problem Solving and Decision Making, R: Reasoning)

Based on Figure 2, it can be seen that the argument analysis (AA) indicator has the highest increase in critical thinking skills based on the N-gain score of 0.74 with high criteria, this is because students are stimulated by the phenomenon of everyday contextual problems that require argument analysis to find solutions to their problems by inserting a science component along with feedback in the problems presented so that it has an impact on improving their argument analysis. An increase also occurred in hypothesis testing (HT) and problem solving and decision making (PSDM) which obtained N-gain scores of 0.73 and 0.71 with high criteria, while in likelihood and uncertainly analysis (LUA) and reasoning (R). obtained N-gain values of 0.67 and 0.64 in the medium category. Based on the N-gain value data for each indicator of critical thinking ability, it was found that the smallest increase occurred in the reasoning indicator. These results are in line with research [31] who found that students experienced the lowest increase in critical thinking skills among other indicators, namely reasoning because there were still difficulties in students in the reasoning process to connect problem solving solutions with existing physics concepts.

The N-gain of each subtopic of heat and temperature is presented in the bar chart in Figure 3.

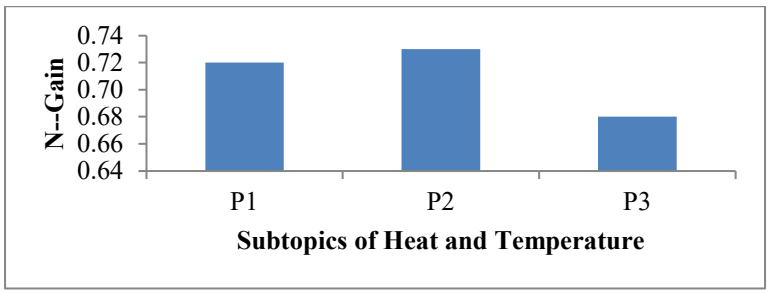


Figure 3. N-gain result by each subtopic of heat and temperature (P1: temperature and expansion, P2: the effect of heat on changes in temperature and shape of the object, P3: heat transfer)

Based on Figure 2, it can be seen that there are differences in the N-gain value in each subtopic, this is due to the characteristics of each subtopic that affect students' critical thinking skills [4]. The N-gain value of P2 (0.73) is higher than P1 (0.72) and P3 (0.68) because students better understand the concept of the effect of heat on changes in temperature/object shape than temperature and expansion and heat transfer. Therefore, the application of the principle of

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temperature and expansion and heat transfer is considered more difficult because it uses a derivative formula that is more complicated than the effect of heat on changes in temperature / shape of objects [10]. At P3 (0.68), the lowest N-gain value was obtained because some of the students still had difficulties in solving heat transfer problems, where some students still have difficulty in analyzing the process of heat transfer by conduction, convection, and radiation because the subtopic of heat transfer has characteristics that are too abstract for students to be able to analyze problems on this transfer topic [5,6,32]. Based on the N-gain value data for each temperature and heat subtopic, it can be concluded that the smallest increase in students' critical thinking skills occurs in the heat transfer subtopic. These results are in line with research [3,7,14] who found that students experienced the lowest increase in critical thinking skills among other sub-discussions of heat and temperature, namely in the sub-discussion of heat transfer, which is because there are still students' difficulties in connecting problem solving solutions with existing physics concepts.

There was a change in the problem solving steps used by students in the critical thinking process which was originally still in the "less" category when thinking critically about problem solving, but after the implementation of PBL-STEM-FA-HB learning, students began to shift the problem solving method to the "good" category. " The percentage of students' critical thinking skills categorization based on the problem solving process in each heat and temperature subtopic is presented in the bar chart in Figure 4.

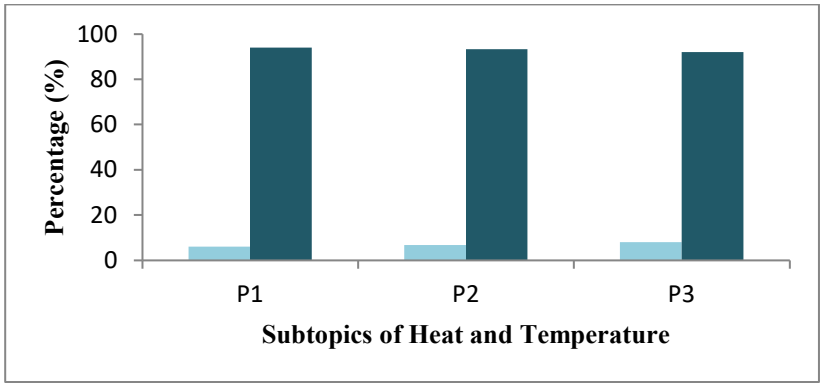


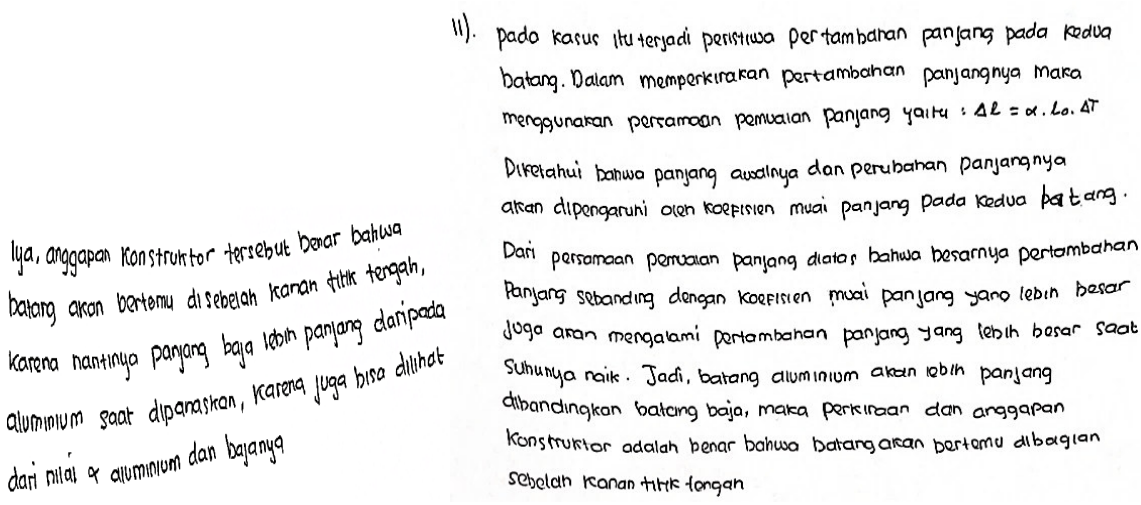
Figure 4. Percentage of critical thinking skill category by each subtopic of heat and temperature (P1: temperature and expansion, P2: the effect of heat on changes in temperature and shape of the object, P3: heat transfer)

Based on Figure 4, it can be seen that the average percentage of the largest (94%) shifting students' critical thinking skills from poor to good at first occurred in P1. While P3 has the lowest percentage among other subtopics, namely 92% of students have experienced a change in critical thinking skills from less to good with the remaining 8% of students still surviving in the poor category. In P2, as many as 93% of students have experienced a change in students' critical thinking skills from less to good where the remaining 7% of students still survive in the poor category. Overall, as many as 58% of students experienced a change in critical thinking skills from poor to good, where students were able to apply their critical thinking processes appropriately and relevant to physics concepts to solve problems. Besides that, students are also able to use mathematical procedures and build the right logic of thinking as outlined in each critical thinking indicator to solve a given problem, while the remaining 42% of students are still in the poor

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category, which still relies on known variables and relies on mathematical equations containing variables. the known variables to solve the problem. This result is in line with research [31] which found that the lowest percentage of heat and temperature subtopics based on changes in students' critical thinking from less to good, namely the heat transfer subtopic, which is because there are still students who have not been able to identify quantities physical magnitude of a problem by interpreting it in the form of problem solving illustrations, and still using mathematical procedures without the right logic thinking to solve the problem.

Based on the increase in critical thinking and the percentage of students' categorization in each heat and temperature subtopic, the temperature and expansion subtopic experienced the highest increase among other subtopics, while the heat transfer subtopic experienced the lowest increase in the temperature and heat topic. Students' critical thinking skills have increased in each category from pretest to posttest. Examples of students' answers to critical thinking processes during pretest and posttest on the subtopics of temperature and expansion (indicator argument analysis) are presented in Figure 5, while examples of student answers on the subtopic of heat transfer (indicator argument analysis) are presented in Figure 6.



(i) **(ii)**

Figure 5. Students' answers on the subtopics of temperature and expansion during pretest (i) and posttest (ii)

Based on Figure 5 (i) it appears that students use critical thinking skills on the argument analysis indicator with the ASKTTRKMM category (a small part of the argument given is correct but not relevant to the concept to solve the problem) in the pretest. Students do not apply the principle of length expansion and students are not able to analyze the relationship between the coefficient of metal expansion and its length increase which causes students' inability to estimate the length expansion that occurs. Whereas rods with a larger coefficient of length expansion should have a larger increase in length. Based on this, some of the arguments given by students are correct but not relevant to the concept of solving the problem. This indicates that the concept of expansion is still difficult for students to deal with. However, after the implementation of PBL-STEM-FA-HB learning, students began to shift their argument analysis skills to the (good) category, namely the posttest answers. It can be seen in Figure 5 (ii) that the arguments given are very specific and relevant to the concept of solving problems (ASSRKMM). Students solve problems starting with

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writing down the correct principle related to long expansion. After being able to determine the right principle, students are able to analyze the relationship between the coefficient of metal expansion and length increase. Furthermore, at the final stage, students are able to assess an opinion and give reasons related to the length expansion problem that occurs in two different types of rods. Solving such problems shows that students have been able to analyze arguments (argument analysis) with categories (good).

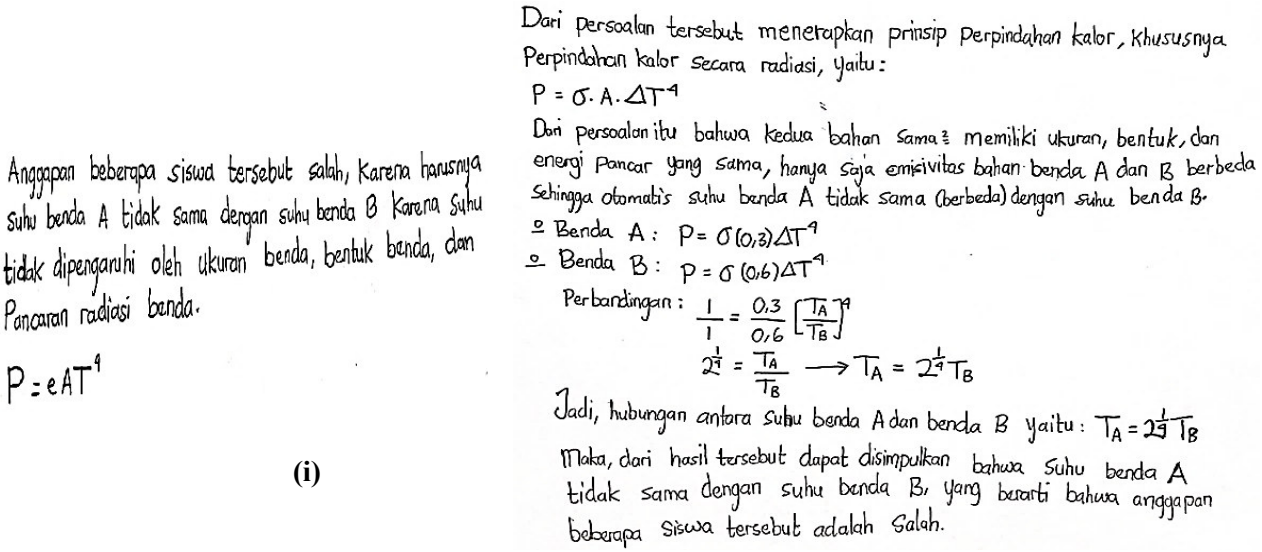


Figure 6. Students' answers on the subtopic of Heat Transfer during Pretest (i) and Posttest (ii)

Based on Figure 6 (i) it appears that students use critical thinking skills on the argument analysis indicator with the ASKTTRKMM category (a small part of the argument given is correct but not relevant to the concept to solve the problem) in the pretest. Students do not apply the principle of heat transfer by radiation so that students are not able to analyze the relationship between the emissivity of the material and the temperature of the object which causes students' inability to estimate the temperature relationship of two objects. Whereas the temperature of the first object should not be the same as the temperature of the second object. Based on this, some of the arguments given by students are correct but not relevant to the concept of solving the problem. This indicates that the concept of heat transfer is still difficult for students to deal with. However, after the implementation of PBL-STEM-FA-HB learning, students began to shift their argument analysis skills to the (good) category, namely the posttest answers. It can be seen in Figure 6 (ii) that the arguments given are very specific and relevant to the concept of solving problems (ASSRKMM). Students solve problems starting with Students solving problems starting with writing down the right principles related to radiation heat transfer. After being able to establish the right principles, students are able to analyze the relationship between size or shape, radiant energy, emissivity, and temperature. Furthermore, at the final stage, students are able to assess an opinion and provide reasons related to decisions in determining the temperature relationship between the two objects. Solving such problems shows that students have been able to analyze arguments (argument analysis) with categories (good).

The results of this study indicate that PBL-STEM-FA-HB learning can improve students' critical thinking skills on heat and temperature material. The PBL-STEM model involves students

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in collaborative-cooperative learning [18,22], meaningful and student-centered learning [33,34], by prioritizing discussion activities [35,36]. This is in line with the findings of [37] which describes the construction process of students' critical thinking, namely, 1) student orientation to problems, 2) organizing students to seek information, 3) sharing together in groups/groups through group investigations 4) developing and presenting work 5) analyzing and evaluate the problem solving process. The PBL-STEM stage is strengthened by applying a hybrid learning method that is able to combine various online learning modalities so as to optimize critical thinking skills during online learning [16,38,39,40]. The PBL-STEM-HB stage is also strengthened by the provision of formative assessments. The existence of formative assessment is able to develop students' scientific abilities by developing students' abilities in group discussions [41-43].

The application of PBL-STEM-FA-HB learning is very helpful for students in improving their critical thinking skills. The use of STEM as a learning approach is able to assist students in illustrating the phenomenon of temperature and heat [44]. PBL-STEM-FA-HB learning involves students in a discussion on making prototypes. These discussions occur through collaborative and cooperative group activities [33,45]. This causes the construction of knowledge through learning experiences experienced by private students [23]. PBL-STEM learning through hybrid learning accompanied by formative assessments is carried out by prioritizing interactions between students in groups so that knowledge exchange occurs. Formative assessment provides feedback that helps students reflect on the learning process and their critical thinking outcomes [24,28,46,47].

Conclusion

The application of PBL-STEM-FA-HB is able to improve students' critical thinking skills on heat and temperature material. The improvement of students' critical thinking skills is in the high category with an N-Gain value of 0.71. The application of PBL-STEM-FA-HB also has a very strong effect on students' critical thinking skills with an effect size value of 6.68. After the application of PBL-STEM-FA-HB, the greatest increase in students' critical thinking skills occurred in the temperature and expansion sub-materials. Changes in critical thinking skills occurred in 58% of students from the less to good category. Further research is expected to add the "Art" aspect so that it becomes a STEAM approach and STEAM-based PBL treatment through Formative Assessment is carried out face-to-face.

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Improving Scientific Argumentation Skills through PBL-STEM with Virtual Simulation Media on Impulse-Momentum Topic

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Abstract. *The skills of students' scientific argumentation about impulse-momentum is very helpful for students in studying physics material. However, Problem-Based Learning with STEM and Virtual Simulation Media (PBL-STEM-MSV) is still rarely done in improving students' scientific argumentation skills. This study aims to determine the effect of PBL-STEM-MSV on increasing students' scientific argumentation skills on impulse-momentum material. This research is a mixed methods research with embedded experimental design involving 28 students of class XI SMAN in Tulang Bawang, Indonesia. The research data were collected through* a *scientific argumentation skills test instruments on the topic of impulse-momentum in the form of 8 essay questions that have a Cronbach's alpha reliskills value of 0.855 (very high category), observation and interviews. Students make simple prototypes in the form of helmets and simple rockets as an application of the impulse-momentum concept. The results showed was a significant increase in students' argumentation skills on impulse-momentum material which has an N-Gain value of 0.56 (medium category) and an effect size of 2.91 (very strong category) which means the application of PBL-STEM-MSV to improve students' scientific argumentation skills, this research is recommended to be widely applied. However, after learning is given there are still students who have difficulty analyzing the principle of the law conservation momentum and the types of collisions in everyday life. Aspects of scientific argumentation that can be achieved are claim, ground and warrant, while the backing aspect has not been achieved by students. Further research is expected to be able to specifically train students to write a rebuttal components and add a control class as a comparison. Recommendations for future research include applying the PBL-STEM-MSV adding an "Art" aspect, and conducting research on other physics topics, not just impulse-momentum.*

Keywords: problem based learning, STEM, virtual simulation media, scientific argumentation skills, impulse-momentum, physics education

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Introduction

The development about science and technology has made education in Indonesia an important center of attention [1]. One of the compulsory subjects for MIA specialization students at the high school level is physical science. Momentum and impulses related to everyday life, this concept can make it easier for students to solve a physics problem [2]. Most students find physics difficult and less interesting [3]. Students only think about and remember physics equations that correspond to different concepts and laws of physics [4]. So that there are often some difficulties in solving physics problems, including on the topic of momentum and impulse. One of them is the difficulty in solving impact problems and solving momentum and impulse problems [5]. It can be seen that students still have a non-optimal mastery of concepts about the concepts of momentum and impulse. The understanding of the concepts studied is also influenced by the student's scientific argumentation skills [6]. Presenting arguments in science learning is a fundamental aspect in the discipline of exposing and resolving inconsistencies between ideas and evidence [7,8].

The skills of scientific argumentation becomes an integral part of learning the concept of physics. The skills of scientific argumentation is an skills that students must have [9]. The learning process in the classroom must train scientific argumentation skills because it can help students respond to phenomena in everyday life by using correct physics concepts [10-12]. The skills to argue scientifically has characteristics that collide with the arguments used daily. This difference is based on the component used in providing the argument. There are six components of scientific argumentation namely claims, data, warrants, rebuttals, endorsements, and qualifications [13,14]. In arguing, one can use evidence to show whether an opinion is true or false [15].

Several studies on scientific argumentation according to [16-19] show that students lack an adequate understanding of argumentation, rarely engage in argumentation and the level of student argumentation is still in the low category. Other studies have also found that students are less able to provide rebuttals to misrepresentations [20]. One of the factors causing the low scientific argumentation of students is the learning process. The application of PBL has a very effective effect in improving students' scientific argumentation skills [21-25]. Some research on the implementation of physics learning related to *problem-based* learning, STEM, virtual simulation media, along with their learning of scientific argumentation skills [26-30]. It appears that research using problem-based learning, STEM, virtual simulation media can each overcome students' scientific argumentation skills that are not optimal, so that the combination of solutions from problem-based learning (PBL), STEM, virtual simulation media is expected to overcome students' not optimal scientific argumentation skills on momentum and impulse materials.

Research on the issue of scientific argumentation skills on topics of momentum and impulses utilizing alternative solutions to STEM approaches is still rare. Aspects of the STEM approach of science, technology, engineering, and mathematics are integrated into a unified learning process [31,32] can enhance the 21st century skills [33,34]. STEM approaches can be integrated into learning science, one of which is Physics [35,36] so the quality of the learning process can improve properly [37,38] making students more skilled problem solvers, creative inventors, and independent learners [39]. According to research conducted [21-23] it shows that the use of *Problem Based Learning* (PBL) learning model can overcome problems in learning

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physics and can improve students' scientific argumentation skills. The PBL model is a learning strategy that involves students in solving problems in everyday life by integrating various concepts and skills from various disciplines [40].

Media-assisted PBL learning, both technology-based media and straightforward media can maximize students' understanding of the material concepts of momentum and impulse 41] making students more active and student learning outcomes levels increasing [42]. The use of virtual media can improve problem-solving strategies, and better conceptual understanding [43,44]. Virtual simulation media technologies that can be used are PhET, Ophysics and Macromedia Flash simulations [45]. Virtual simulation media can replace props without having to be connected to the internet and require less equipment so that their use is more efficient both in terms of time and cost [46-48].

This research applies the PBL model with the STEM approach assisted by virtual simulation media to improve students' scientific argumentation skills in impulse-momentum topics. The purpose of this study was conducted to determine students' scientific argumentation skills in impulse-momentum topics by applying PBL-STEM-virtual simulation media. In addition, it can explain students' scientific argumentation skills before and after the application of the PBL learning model.

Method

This study used a mixed research method by applying an embedded experimental design [54]. The subjects of the research were 28 students of class X MIPA SMA in Tulang Bawang. The subjects of the research were determined using the Cluster Random Sampling technique. The researcher considered all classes have to the same characteristics [54]. PBL-STEM with virtual simulation media learning is applied to improve scientific argumentation skills as outlined on Table 1.

Table 1. The Design of PBL-STEM with Virtual Simulation Media Learning on Scientific Argumentation Skills

No.	*Syntax of PBL*	*STEM approach*	*Virtual Simulation Media*	*Argumentation Skills*
1.	*Organizing studentd into problem*	*(Science, Technology, Mathematic)*	*Explanation about Virtual Simulation Media to students*	*Claim*
2.	*Organizing students to learn*	*(Science, Technology, Mathematic)*	-	*Data*
3.	*Asisting independent and group investigations*	*(Science, Technology, Mathematic)*	*Performing an investigation with the help of Virtual Simulation Media*	*Data, Warran/ Reasoning*
4.	*Developing and presenting works and exhibitions*	*(Science, Technology, Engineering, Mathematic)*	-	*Reasoning/ Reasoning, Backing*
5.	*Analyze and evaluate the problem solving*	*(Science, Technology, Mathematic)*	*Analysing and evaluating with the help of Virtual*	*Backing*

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	process		*Simulation Media*	

This research instrument consisted of 8 scientific argumentation skills test items in the form of essay with a reliskills of 0.855 (very high category), interview guidelines, and observation sheets. Overall, the study began with a pretest, then continued with treatment, and ended with a posttest, and in between interviews and observations were conducted. Based on the results or the analysis of validity and reliskills presented on Table 2.

Table 2. Validity and reliskills test

Question Number	Validity	Description	Reliabilitas	Description
1	0,359	Valid	0,740 (High Category)	Reliabel
2	0,579	Valid		
3	0,635	Valid		
4	0,670	Valid		
5	0,583	Valid		
6	0,771	Valid		
7	0,690	Valid		
8	0,574	Valid		

Before the pretest, researchers conducted interviews related to students' initial understanding and previous learning process habits carried out in schools. The pretest results provide information related to the student's initial knowledge and student skills when completing the test before being given treatment. Furthermore, an interview was conducted to find out the student's rationale for the answers written at the time of the pretest. The next stage is the provision of treatment using the PBL-STEM model assisted by virtual simulation media. During the action treatment, the researcher collected data in the field notes from the rubric assessment and observation to students. During the learning students make a simple prototype in the form of Helmets and Rockets as an application of the impulse-momentum concept. At the end of the lesson, a posttest was given to analyze student's scientific argumentation skills after being given treatment. Then an interview is conducted to obtain in-depth information about the difficulties students experience in learning impulse-momentum. Data analysis in this study consists of two parts, namely qualitative data and quantitative data. Qualitative analysis is carried out by looking at how students think about the concepts of momentum and impulses, knowing the difficulties experienced during learning, and being a reinforcement of the findings of quantitative results.

The data analysis method used is quantitative analysis in the form of paired sample t-tests to determine differences in students' scientific argumentation skills [49], the N-gain test is used to determine the increase in students' scientific argumentation skills [49] and the d-effect size is used to determine research effectiveness [49]. Researchers collected data in the form of field notes from the assessment and observation rubric. Then an interview is conducted to obtain in-depth information about the difficulties students experience in learning impulse-momentum. Qualitative data from interviews and observations conducted directly to students were analyzed using data reduction, coding, and interpretation [50].

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Assessment of scientific argumentation skills is carried out using the Toulmin Argumentation Pattern (TAP) framework developed by [13]. The components of scientific argumentation skills include claims, data, warrants, rebuttals, supporters, and qualifications. Furthermore, students are grouped into five scientific levels of argumentation skills presented in Table 3 under.

Table 3. Toulmin's Argumentation Pattern Framework (TAP)

Level	Descriptions	TAP Compomemt	Category
Level 1	Scientific claim	Claim	Very weak
Level 2	Coordination between claims and evidence	Claim and Data	Weak
Level 3	Reasonable coordination between claims and evidence	Claim, data and warrant/backing	Quite stong
Level 4	Modified from the coordination between claims and evidence	Claim, data, warrant/backing, and qualifier	Strong
Level 5	Conditional, modified, and coordination complete between claims and evidence	Claim, data, warrant/backing, qualifier and rebuttal	Very strong

Result and discussion

Analysis of students' scientific argumentation skills after applying the Problem Based Learning learning model integrated STEM with Virtual Simulation Media (PBL-STEM with VMS) on impulse-momentum topics is carried out through several stages, namely statistical descriptions, normality tests, different tests with paired sample t-tests, N gain calculations, effect size calculations, and analysis of student answers per question. Description of statistics before and after learning is applied in Table 4.

Table 4. Statstical description of students' scientific argumentation abilty

Statistic	Pretest	Posttest
N	28	28
Min	19	50
Max	53	90
Mean	31.79	69.43
Standar Deviation	8.057	11.783

The results in the table show some important values about the distribution of students' scientific argumentation skills data. Several data such as mean, median, maximum-minimum value, and standard deviation are known to be able to interpret the data. The average score before and after learning obtained shows an increase in students' scientific argumentation skills. From an average score of 31.79 to 69.43. Furthermore, data from students' scientific arguments will be tested for normality to be able to proceed to different tests. The results of the analysis normality test with shapiro-wilk test of students' scientific argumentation skills test of impulse-momentum topics are shown on Table 5.

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Table 5. Normality test of scientific argumentation skills

Data	Shapiro-Wilk		
	Statistic	df	Sig.
PreTest Score	0,943	28	0,136
PostTest Score	0,933	28	0,072

The results of the shapiro-wilk normality test analysis show that the pretest and the posttest scores for scientific argumentation skills are normally distributed so that different tests can be carried out using paired sample t-test. The results of the paired sample t-test is used to fine out whether there is a significant difference after the application of Problem Based Learning learning that is STEM integrated with Virtual Simulation Media (PBL-STEM with VMS). The results of the different tests using the paired sample t-test of students' scientific argumentation skills can be seen on Table 6.

Table 6. Paired sample t-test

	Pretest-Posttest
Std. Deviation	9.190
Std. Error Mean	1.737
t	-21.674
df	27
Asymp. Sig. (2-tailed)	0,000

Based on the data from different test analysis using the Paired Sample T-Test test above, it can be concluded that there are differences in students' scientific argumentation skills before and after learning PBL-STEM with virtual simulation media. It can be known by looking at the values of t and Asymp. Sig. (2-tailed). The value of t obtained was -21.674 with Sig. (2-tailed) 0.000 < 0.05. This means from the PBL-STEM learning model assisted by virtual simulation media has an effect on improving students' scientific arguments.

This study was conducted to improve students' scientific argumentation skills. The treatment given in research is the application of Problem Based Learning (PBL) learning model that is STEM integrated with Virtual Simulation Media (PBL-STEM with VMS). There are six components of scientific argumentation namely claims, data, warrants, rebuttals, endorsements, and qualifications [13,14]. The discussion in this study focused on the application of PBL-STEM with MSV in improving students' scientific argumentation skills and the difficulties experienced by students after treatment. The combination from PBL-STEM learning models with VMS can improve students' scientific argumentation skills in impulse-momentum topics. In line with the research conducted by [21,28,29,30] showed that learning by applying PBL learning can improve students' scientific argumentation skills and the research conducted by [23] showed that the application of PBL-STEM can improve students' scientific argumentation skills. In this study, students developed and created two prototype-shaped technology products in the form of helmets and simple rockets as an application of the impulse-momentum concept in everyday life.

In addition, students can also improve, modify or perfect their products based on input from other groups when presenting products in front of the class. In addition, students are also given the task of making a poster and written report about the product they have made. STEM integration into science learning, one of which is physics, makes students more aware of

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connecting education in schools with real life [51]. In addition, the integration of STEM into PBL can make students more confident and more enthusiastic in learning and make learning more interesting in terms of the learning activities carried out [52,53]. Learning that is done using the STEM approach is proven to be able to assist teachers in improving students' abilities in understanding physics learning based on research results [54-58].

Based on the research results, the application of PBL-STEM-VMS can significantly improve students' scientific argumentation skills on impulse-momentum material. This is shown by the N-Gain value of 0.56 (moderate category) as shown on Table 7.

Table 7. N-gain score

Indicator		N-Gain Score	Category
Analyze the concept and relationship of momentum and impulses	QN 1	0,63	Medium
	QN 2	0,72	High
	QN 5	0,57	Medium
Mean		0,64	Medium
Analyze the principle of the law conservation momentum and the types of collisions	QN 3	0,63	Medium
	QN 4	0,54	Medium
	QN 6	0,42	Medium
Mean		0,53	Medium
Analyze the results and present the results of momentum and impulse events	QN 7	0,34	Medium
	QN 8	0,61	Medium
Mean		0,47	Medium
Min.		0,34	
Max		0,72	
Mean		0,56	Medium

In this impulse-momentum topic research discusses three indicators consisting of 8 essay questions. The indicators are first, analyzing the concepts and relationships of momentum and impulses for questions number 1,2, and 5, secondly analyzing the principle of the law conservation momentum and the types of collisions for questions number 3,4, and 6, and thirdly analyzing the results and presenting the results of momentum and impulse events for questions number 7 and 8. Each indicator has different Ngain indigo. The largest Ngain value is produced in the indicator analyzing the concept and relationship of momentum and impulse with the Ngain value of question no 1 of 0.63, question no 2 of 0.72, and question no. 5 of 0.57 so that the average Ngain of the first category is 0.64 (medium category), while the indicator that has the smallest Ngain value is an indicator of analyzing the results and presenting the results of momentum and impulse events with the Ngain value of question no 7 of 0.34 and question no 8 of 0.61 so that the average Ngain of the third category is 0.47 (medium category), then the indicator analyzes the principle of the law conservation momentum and the types of collisions with the Ngain value of question no. 3 of 0.63, question no. 4 of 0.54, and question no. 6 of 0.42 so that the average of the second category of Ngain is 0.53 (medium category). From each indicator, the average value of Ngain's research on the application of the STEM Problem Based Learning learning model which is integrated with Virtual Simulation Media (PBL-STEM with

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VMS) is 0.56 (medium category) which means that there is an increase in students' scientific argumentation abilities due to learning the application of PBL-STEM with VMS in medium category. So, it can be concluded that the combination of PBL-STEM learning with VMS can improve students' scientific argumentation abilities on impulse-momentum material. This is also supported by the results of previous research that problem-based learning (PBL) can help improve students' scientific argumentation skills [26,28,59,60,61].

In addition, to determine the effectiveness of the applied learning model, it can be seen using the results of the effect size test. PBL-STEM-VMS learning also has a strong influence in improving students' scientific argumentation skills in terms of the effect size value of 2,912 (very high category) as shown in Table 8.

Table 8. Effect Size Score

Data	N	Mean	SD	Effect Size	Category
PreTest	28	31.79	8.057	2,912	Very Strong
PostTest	28	69.43	11.783		

The calculation of the percentage distribution of scientific argumentation levels in students' answers to pretest and posttest learning results of PBL-STEM-VMS is shown in Table 9.

Table 9. Percentage of scientific argumentation skills

Kategori	Level 1		Level 2		Level 3		Level 4		Level 5	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
%	58,93	1,34	21,43	25,89	10,71	27,23	8,48	31,70	0,45	13,84

From Table 9, we can see that the dominant students are still at level 2, level 3 and 4. It can be seen that before learning at level 1 there are 58.93%, at level 2 there are 21.43%, at level 3 there are 10.71%, at level 4 there are 8.48%, and at level 5 there are 0.4% who have scientific argumentation skills. Meanwhile, after learning PBL-STEM-VMS, there was a significant increase seen in level 1 there was 1.34%, at level 2 there was 25.89%, at level 3 there were 27.23%, at level 4 there were 31.70%, and at level 5 there were 13.84%. The lowest level of argumentation after learning is at level 1 (1.34%) and the highest level of argumentation is at level 4 (31.70%). This shows that the application of PBL-STEM-VMS can greatly improve students' scientific argumentation skills on impulse-momentum topics.

Some of the students' difficulties in scientific argumentation skills were discovered after applying the PBL-STEM learning model with VMS. After conducting interviews with several students, it turns out that students still experience some difficulties such as not fully understanding the concept of impulse-momentum, students' inskills to discuss facts and scientific concepts based on problems in everyday life, students' inskills to provide evidence and provide rebuttals to the questions given. In addition, it was also found that students can provide true claims and evidence accompanied by support to the evidence given, then, claims that are true but use incomplete evidence, as well as claims that are true but the evidence provided is false. In scientific argumentation students must be able to provide valid and verifiable evidence [62]. In

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addition, there are still some students who cannot conclude arguments correctly, which means that these students cannot determine whether the answer is right or wrong [63-65]. Scientific argumentation involves many elements such as identifying the truth of evidence, the mental capacity to admit conflicting claims, and the skills to fairly refute claims [66]. Meanwhile, the student with the highest improvement in scientific argumentation skills when interviewed provides information about the actions that have been taken to improve his scientific argumentation skills, he said that in arguing must have confidence in the argument proposed. The student's confidence in his argumentation influenced the development of his scientific argumentation [67]. Self-confidence can create students' courage to argue so that argumentation activities develop.

The learning process carried out by applying the PBL STEM model with VSM has been proven to be able to improve students' scientific argumentation abilities. Although the increase in the level of scientific argumentation that occurred before and after learning the application of PBL STEM with VSM was still not so great. However, these differences still have a positive impact and influence on students. The STEM aspect in the PBL model can help students be more active in learning by applying their knowledge to solving problems in everyday life and increasing students' attitudes and interests [68,69]. In this study, VSM played a role in improving students' argumentation skills. On learning PBL-STEM-VSM is presented with more complex and demanding problems the product must be ready to be tested. The VSM used in this research is PhET, Ophysics and Macromedia Flash simulations, where VSM can replace props that are often used in schools because their use is more efficient both in terms of time and cost [45-47]. VSM-assisted PBL learning became one of the alternative models to make students more active and the level of student learning outcomes increased [42,70].

Conclusion

Students' argumentation skills through learning with the application of the PBL-STEM model assisted by virtual simulation media show good results. The combination of PBL-STEM syntax with virtual simulation media is designed to bring out every component of a argumentation skills which includes claims, data, warrant, rebuttals, endorsements, and qualifications. Students' scientific argumentation skills increased before and after learning with an N-gain of 0.56 (moderate category) and a d-effect measure of 2.91 (strong category). However, after learning there are still difficulties experienced by students in completing the argumentation component and strengthening claims with evidence and refutations. In addition, students also experience difficulties such as not fully understanding the concept of impulse-momentum, students' skills in providing evidence and providing rebuttals to the questions given. The application of PBL-STEM with virtual simulation media can also be used for other physics topics, but these topics need to be considered so that they are suitable for learning methods and provide an "Art" aspect.

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Development of student worksheet utilise a scientific approach use the virtual phet laboratory on Dynamic Electricity Material

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Abstract.*The general physics course integrates with the general physics practicum. Because it is still Blended Learning, students are directed by supporting lecturers to use virtual laboratories. Students find it challenging to carry out experiments in virtual laboratories because they cannot use and need to learn the methods and materials. So the media used to overcome the problem above is to make student worksheets with a scientific approach. With this approach, students are directly involved with observing activities, formulating problems, collecting data, associating, and communicating. The purpose of this research is to develop appropriate student worksheets and also to find out student responses to student worksheets. The data analysis using qualitative and quantitative data analysis techniques by describing the material and media experts' feasibility and student responses. Data collection tools in this study were a questionnaire, observation and documentation. The results of the assessment and responses from filling out the questionnaire: (a) the percentage of assessment scores from material experts 87.33% (b) the percentage of assessment scores from media experts 92% (c) the percentage of response scores from students reviewers 86% obtained from the questionnaire.*
Keywords: general physics, phet, virtual laboratory

Introduction

Physics comes from the word "physic" which means nature. So physics is a science that studies nature and natural phenomena or natural phenomena and all the interactions that occur in it.With physics, humans can get scientific truth from existing natural phenomena. Scientific skills

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can be implemented in the classroom using learning methods that facilitate process learning, but they can also be implemented through practical work in the laboratory [12]. One of the learning methods used in the laboratory is the experimental method. The experiment is an experimental activity to examine an event or symptom that appears under certain conditions using careful observation and control so that a causal relationship can be known from the emergence of these symptoms.

The digital era encourages innovations where technology has opened up the possibility of new science learning processes in the form of virtual laboratories. Virtual laboratories can be used as a solution for conducting experimental activities whenever and wherever students are. A virtual laboratory is an IT-based learning media. Learning media can clarify the presentation of messages and information, lead to learning motivation, and overcome the limitations of the senses, space, and time [16]. The same happened in the Department of Physics, State University of Medan. It's been two years since students did practicum in the Physics Laboratory. Based on a survey with students in the Department of Physics, namely: (a) for 2020 stamp, class Dik A and Dik B have done Virtual laboratory practicum on electrical and optical materials, while class Dik C has done direct practicum for students who live in the city of Medan only and Dik D does not use a virtual laboratory, (b) for the 2021 stamp for classes A and B, the lecturer has given a virtual laboratory assisted by laboratory assistants, for class C and Dik D have never done virtual laboratories, students are given youtube videos, or use applications simple because educators have limitations in using the Virtual Laboratory.

After the Covid 19 period, learning was still carried out in a blended learning manner to conduct Physics experiments directed using existing virtual laboratories. Virtual laboratories can be used as a solution and have functions and objectives to provide conceptual and procedural knowledge [14]. This experiment makes students more interested so that students can carry out experiments well [10]. However, many students still need help running virtual laboratories, so students need student worksheets to direct them in conducting experiments.Based on the problems above, a virtual laboratory-based student worksheet is needed. Student worksheets made on general physic sub material electricity material. Many experiment s regarding dynamic electricity using the pHet laboratory. Worksheets as a tool and a guide for students in conducting experimental activities.

PhET is a site that provides physics and chemistry learning simulations provided for free by the University of Colorado [18]. To help students understand visual concepts, PhET simulations animate quantities using graphics and intuitive controls such as click-and-drag, rulers, and buttons. The scientific approach is learner-centered and can directly experience objects and stimuli in the learning environment. Research [13] shows that worksheets are very interesting, easy, and very useful, as well as effective products as learning media, with a percentage of student learning outcomes more than 80% who have achieved graduation in cognitive and affective aspects. Student worksheets are intended to provide understanding for students to know, understand. A student worksheet is a printed teaching material in the form of sheets of paper containing material, summaries, and instructions for carrying out learning tasks that must be done by students, both theoretical or practical, which refers to the competencies students must achieve, and its use depends on other teaching materials [9]. Virtual laboratories can be multisensory software with interactivity to simulate certain practicums by replicating conventional laboratories. Virtual laboratories allow students to learn through a case study approach, interact with laboratory

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equipment, conduct experiments, analyze experiments, and evaluate the processes being carried out. Students can see inside their devices through visual displays, animations, and adapted representations of real laboratories. With a virtual laboratory, the possibilities for exploring, experimenting, and learning become more dynamic. In use, a virtual laboratory requires hardware that supports specific user inputs. The input in question includes: pressing a button, touching the screen, or through the movement of the user's limbs (gesture). The types of hardware to operate virtual laboratories are increasingly diverse as technology develops, ranging from computers, consoles (Digital Player Console), wall projection CAVE (Cave Automatic Virtual Environment), gadgets (mobile phones), and virtual reality devices (Head Mounted Display) [19]. Previous research is the Development of Student Worksheets Utilizing Virtual Laboratories on Optical-Physical Materials with a Scientific Approach [17] Product which had been validated, showed that student worksheet was very interesting, easy, and very useful and it was effective as learning media with percentage of the student study result more than 80% had reached the passing grade in cognitive and affective aspects.. The Use of Physics Virtual Laboratory Student Worksheet in Fluid Material Scientific Approach to Student Learning Outcomes of Class XI SMAN 14 Padang [4]where is can be stated from Research the results of this investigation is the applied virtual laboratory student worksheet in scientific approach has given significant effect on physics learning outcomes of students on knowledge aspect, attitude aspect and skills aspect in class XI in SMA N 14 Padang at the siginificant level of 0.05. The purpose of this study are a) to develop feasible student work sheet b) to find out student responses to the work sheet.

Methodology

The type of research being carried out is Development Research which is used to develop a new product or perfect an existing product to meet the specified criteria [10]. Development research uses the 4 D model (Define, Design, Develop, Decimate). The subjects of this study were: 1) class 2018 Dik students for product trials and product response tests. 2) Material experts are validators with a scope of expertise in the material field for validating material on student worksheets. 3) Media experts as expert validators with a scope of expertise in learning media to validate student worksheets quality. Data analysis techniques are quantitative and qualitative data. Data collection techniques in this study used observation, interviews, and questionnaires. 1) Observations were made at the Department of Physics, State University of Medan, to find out information about learning support facilities and infrastructure, the conditions and needs of students, including knowledge, attitudes, and skills. 2) Interview with lecturers in general physics courses. The purpose of this interview is to find out the problems encountered in the general physics learning process and students' needs for student worksheets assisted by a virtual laboratory that will be developed. 3) Questionnaires are used to obtain information by providing several written questions to respondents [15]. The questionnaire used in this study was addressed to a) students to obtain responses regarding students' difficulties in learning physics and student responses to the developed multimedia, and b) material and media expert validators to find out information about the feasibility level of the developed student worksheets. Qualitative data were obtained from the survey results in interviews before researching the 2018 B stamp of the Physics Department at State University of Medan. Criticisms and suggestions for products developed. Quantitative data consists of assessment scores by material experts, media experts, and students for student worksheets. For student responses are given by the class the 2020 D stamp.

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For Eligibility Percentage

Table 1. Percentage scale

Achievement Percentage	Scale	Interpretation Value
76% ≤ score ≤ 100%	4	Very feasible
51% ≤ score ≤ 75%	3	feasible
26% ≤ score ≤ 50%	2	Enough feasible
0% ≤ score ≤ 25% 1	1	Not feasible

Analysis of student assesment questionnaire data on the developed learning media using the likert scale method [15].

$$P = \frac{X}{Xi} \; x\,100\%$$

Description:

P = percentage of each criteria. X = score of each cirteria. X_i = maximal score of each criteria.

Table 2. Student assessment score guidelines

Evaluation	Scale	Score
SS	Agree completely	5
S	Agree	4
KS	Disagree	3
TS	Nor disagree	2
STS	Strongly disagree	1

Futhermore,all data from student assesment questionnaires were recapitulated and calculated for each statement item [2],using the following formula:

$$P = \frac{Total\ scores\ of\ data\ collection\ results}{Total\ score\ of\ criteria\ maam} x\,100\%$$

Table 3. Score interpretation criteria

No	Score interval (%)	Category
1	81-100	Very good
2	61-80	Good
3	41-60	Adequate
4	21-40	less
5	0-20	Very less

Results and discussions

The results showed that the Student Worksheet for electricity dynamic was very worth to use.

Research result

1. Define

The product developed is a student worksheet based on a scientific approach assisted by a Virtual Laboratory. The phases of 4D:

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1. Define
   This phase is the initial activity by conducting a needs analysis and literature study to determine the product to be developed.
   a. Front-end Analysis
      In this activity, an analysis is carried out regarding the basic problems encountered in the learning process. In this activity, interviews were conducted with one of the lecturers who teach general physics courses to obtain information related to learning activities, students' understanding of physics material, student attitudes during the learning process, and constraints in the general physics learning process, including general physics practicum. In addition, this activity was carried out by distributing questionnaires to students to obtain information related to interests, understanding, and experiences in the general physics learning process.
   b. Learner Analysis
      In this activity, an analysis of student characteristics related to student characteristics relevant to the product being developed, academic abilities, student motivation, and skills on topics, media, display, and language used in learning.
   c. Task Analysis
      In this activity, students' skills are analyzed into the main tasks that students must master to achieve the specified minimum competencies. In this activity, a questionnaire was distributed to students to obtain information related to the set of assignments given by the teacher, the technical work of the tasks, the criteria, and the framework of the assignments given by the teacher.
   d. Concept Analysis
      In this activity, an analysis of the concepts that will be taught regarding dynamic electricity is carried out. Develop competencies to be achieved and develop steps to be taken.
      e. Specifying Instructional Objectives
      In this activity, a summary of the results of concept analysis and task analysis is carried out to become the objectives expressed through learning activities.

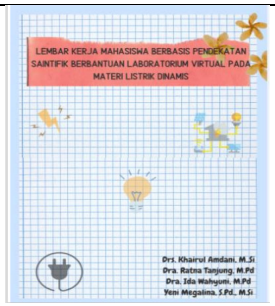
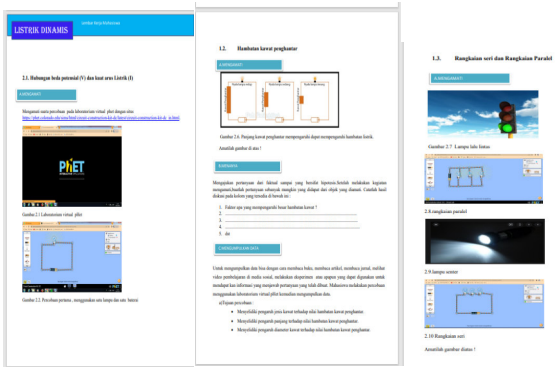
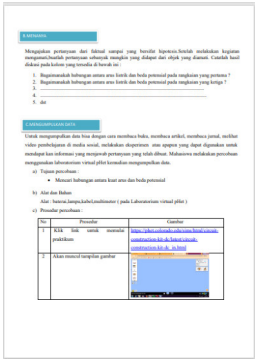
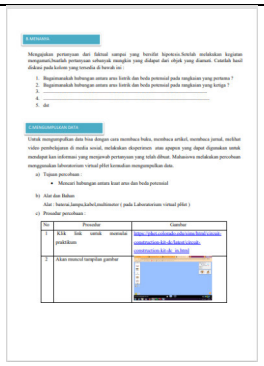
2. Design

This phase is the activity of designing the product to be developed. The design stages include:

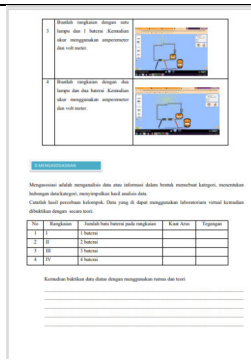
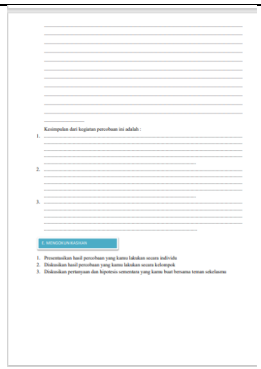
   a. Media Selection
      In this activity, the researcher analyzes the learning tools according to the material to be selected. The goal is to suit student needs. Select student worksheets with the help of the PhET virtual laboratory[8].
   b. Format Selection
      In this activity, instructional media designs were formulated, choosing strategies, methods, approaches, and learning resources.
   c. Initial Design
      In this activity, the researcher did the initial design of the Student Worksheet product to be developed.

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Table 4. The student worksheet on wave material

No	Figures	Description
1		Cover of student worksheet.The material discussed in dynamic electricity are a) The relation ship between potential difference and electric current strength,conductor wire resistance,series circuits and parallel circuits.
2		Observe.Student observe the picture.
3		Ask, after student observe the picture,then student will ask question
4		Collecting data.Student collect data based on experiments that have been done.

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5		Associate,the student association analyzes the data that has been obtained and then proves it theoretically.
6		Communicating.Discuss the results of the experiment and present them in groups

3. Develop

The activity of making Student Worksheets with a scientific approach from designs that have been made previously then tests the feasibility of the product so that the product gets suggestions for improvement and becomes a product with the desired goal. This phase includes two main steps, as follows:

a. Expert Appraisal
   Expert assessment is a feasibility technique carried out by experts to get suggestions for improving multimedia materials and designs. Conducting validation by material experts and media experts.
b. Developmental Testing
   After the expert assessment stage and revisions are carried out, student worksheets are given to students to get responses to the media products being developed.

- Material Experts

Based on a feasibility questionnaire by a material expert, it includes three aspects, namely content feasibility, presentation feasibility, and readability. The data on the results of the feasibility by the material expert can be seen in the table below is the result of the assessment of the material expert in terms of (1) content feasibility, obtaining a score of 16 (80%), (2) presentation feasibility obtaining a score of 20 (100%) (3) Language feasibility 37 (82%) Overall, the eligibility questionnaire obtained a score of 73 (87,33%).

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Table 5. Eligibility by material expert

No.	Aspect	Frequency					Score	Question points	Max	Percentage (%)
		1	2	3	4	5				
1	Content eligibility	0	0	0	4	0	16	4	20	80
2	Serving eligibility	0	0	0	0	4	20	4	20	100
3	Legibility	0	0	0	8	1	37	9	45	82
Total							**73**	**17**	**85**	**87,33 %**

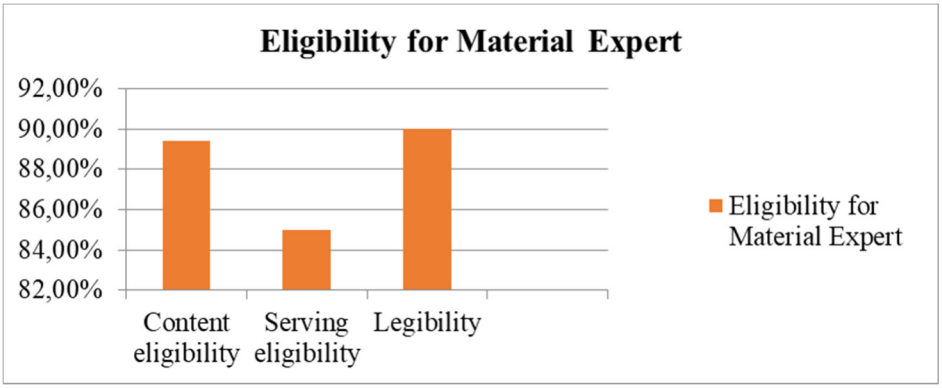


Figure 1. Feasibility diagram by material expert

- Media Expert Review

The feasibility questionnaire for media expert includes four aspects: aspects of media appearance, presentation feasibility, visual aspects and linguistic aspects. The results of this media expert's assessment were viewed from the following aspects: (1) the display got a score of 8 (90 %), (2) the feasibility of the presentation got a score of 14 (93%), (3) the graphic got a score of 57 (95%) and (4) the feasibility of the language obtained a score of 57 (95%). Overall the level of media validation obtained a score of 98 (92%). Look at the table below:

Table 6. Eligibility by media expert

No.	Aspect	Frequency					Score	Question points	Max	Percentage
		1	2	3	4	5				
1	Appearance	0	0	0	1	1	9	2	10	90%
2	Serving eligibility	0	0	0	1	2	14	3	15	93%
3	Graphics	0	0	0	3	9	57	11	60	95%
4	Language	0	0	0	2	2	18	4	20	90%
Total							**98**	**20**	**105**	**92%**

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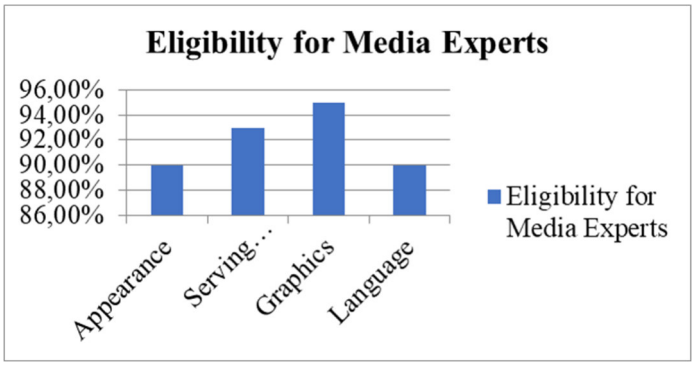


Figure 2. Feasibility chart by media experts

- Initial field trial

After students open the media worksheets, students are then asked to respond (responses) by filling out student response questionnaires. This response questionnaire consists of 20 questions. The results of this trial assessment are viewed from the aspects: (1) interest, obtaining a score of 152 (84%), (2) presentation of student worksheets, obtaining a score of 452 (87%), (3) learning components based on virtual-assisted scientific approaches laboratory, obtained a score of 395 (86%). Overall score 999 (86 %) Based on the table of the scale of the eligibility criteria, it is included in the very good category.

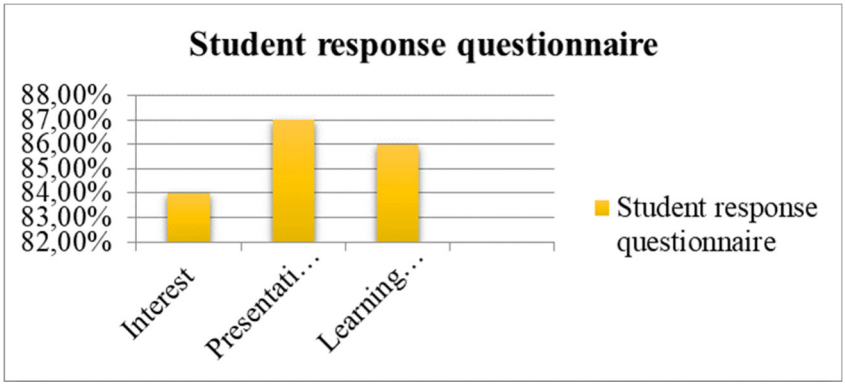


Figure 3. Dik D class stamp 2020 group response

Table 7. Student questionnaire response

No.	Aspect	Frequency					Score	Question points	Max	Percentage
		1	2	3	4	5				
1	Interest	0	0	3	22	11	152	36	180	84%
2	Presentation	0	1	11	43	49	452	184	520	87%
3	Learning Component	0	0	15	35	42	395	92	460	86%
Total							**999**	**312**	**1160**	**86%**

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Research result

This research develops learning media that are suitable for use. The general physics course integrates with the physics practicum. This worksheet uses a scientific approach to the subject of Dynamic Electricity (Relationship of potential difference (V) and electric current strength (I), resistance of conducting wires, electric circuits, and parallel circuits). The stages of the scientific approach are a) The students' task is observing an experiment in the PhET laboratory with the link: https://phet.colarado.edu/ b) Ask questions, students give factual questions to hypothetical ones based on observations. c) Collect data, and students conduct experiments at PhET. d) Associate, students record experimental data regarding Dynamic Electricity and then make discussions and conclusions based on experiments that have been carried out. e) Communicating, namely, students presenting and discussing experimental results in groups [1].

The type of development research used is Research and Development (R & D) 4 D (Define, Design, Develop, Disseminate). The steps of this research are a) Define, by conducting needs analysis and literature study to determine the product to be developed, namely conducting front-end analysis, student analysis, task analysis, concept analysis, namely dynamic electricity material, then formulating learning objectives. b) Design, the activity of designing the product to be developed, choosing the media, and choosing the format, including: choosing the media, namely student worksheets assisted by the PhET laboratory. This PhET application is used because it is clear, interactive, complete material, and has exciting features. Student Worksheets are produced via laptops using several applications, namely Word, Canva, and also a virtual laboratory. Word is used to write and edit student worksheets. Canva is used to make covers and make student worksheets more attractive than using the PhET virtual laboratory and can be accessed for free via https://phet.colarado.edu/. c) Development, testing the feasibility of the media. To get suggestions for improving materials and media. By validation by experts, suggestions are obtained that are used as material for product revision of student worksheets. Based on the input of experts, the media is appropriate, usable, and of good quality. Material assessment is carried out by material experts, namely Physics Education lecturers, State University of Medan, to evaluate material with language indicators, suitability with achievements, and suitability of material with student worksheet products developed. Furthermore, the assessment of multimedia products is carried out by media experts, namely Physics Education lecturers, State University of Medan, to evaluate the format, framework, and use of the developed media, d) Dissemination, give student worksheets to Physics lecturers, then they can be distributed to students taking general Physics courses.

After this student worksheet is designed and made, the feasibility of this media is assessed by material experts and media experts. The feasibility assessment was measured based on the results of material experts with a score of 73 with an achievement percentage of 87,33 % and media experts showed a score of 98 and a percentage of achievement was 92 %. Thus, this student worksheet media is classified as a very feasible criterion. After being assessed according to the expert, the media of this worksheet was revised according to the suggestions and comments of the experts. Furthermore, this media is given to the initial field or small groups, namely students from the Physics Department of Dik D stamp 2020. The results of the responses are scores and percentages of small group students, with 86 % with very good criteria. Based on the table of the scale of the eligibility criteria, it is included in the very feasible category. This research model only uses three stages, the deployment stage was not carried out due to time constraints.

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Responses by material expert to worksheet media are the worksheet direct and help students to be able to encourage and motivate students to conduct virtual experiments, are vaery attractive so that they attract students interest. Overall the worksheet are very well-made and interesting. While responses by media expert to the use of language must be following EYD,correct the writing of the prefix in for verbs and the prepodition in for adverbs of place.

The responses from this student worksheet are that a) using a virtual laboratory can advance students' minds to use technology b) foster curiosity to learn it c) this worksheet is very easy to understand and attracts interest to study it [13]. d) can be used wherever and whenever we are [4], not necessarily face to face e) this worksheet is very helpful for students in conducting experiments and understanding the material f) student worksheets with a scientific approach motivate students to study the material and conduct experiments g) these worksheets are very easy to understand h) using virtual laboratories are safer and more efficient i) student worksheets are clear, complete and easy to understand making readers interested in learning material j) This worksheet provides easy-to-open links and virtual laboratory barcodes, then also put the experimental steps and pictures taken from the virtual laboratory so that students are not confused in conducting experiments. Suggestions for this media are a) in using this virtual laboratory, it must have a good internet network b) The image in the experimental steps is enlarged c) The color of the cover of this worksheet is too soft, it should be combined with a light color to attract attention. Based on the results of the assessment and responses obtained from the questionnaire, and the test given, the resulting product in the form of a Student Worksheet based on a scientific approach is very feasible, very good use and develop.

Conclusion

The conclusion of this research is: a. The results of the feasibility of experts on Student Worksheets with a scientific approach assisted by a virtual laboratory pHet show the criteria are very feasible. b. Based on the students' responses Dik C stamp 2020 is obtained 86 % very good category.

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Development of stellar augmented reality as a visualization of the wien's displacement

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Abstract. *Physics is one of the basic sciences. Physics concept that are abstract and hard to observe make it difficult for student to learn. This study aims to develop stellar augmented reality to visualize the phenomenon of Wien's Displacement. This research and development are carried out using a waterfall development model consisting of four stages, namely analysis, planning, coding, and testing. The subject of this study is a physics education student of Universitas Negeri Malang. The test results showed that: (1) The stellar augmented reality product is able to interfere well, (2) the stellar augmented reality product is able to visualize the Wien's displacement phenomenon, (3) the validation results show that the stellar augmented reality is suitable for use. The validation results by media experts obtained a score of 86 out of 100 with a very decent category, while the user assessment results obtained a score of 80 out of 100 with a decent category.*

Keywords: augmented reality, wien's displacement, quantum physics

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Introduction

Physics is one of the basic sciences. An understanding of physics is required to understand another general area [1]. In fact, physics is one of the subjects in science that is difficult for students to understand. The result of the national exam shows a low mastery of the concept of mechanics, waves, magnetism, and quantum physics [2]. The difficulty of students in understanding the concepts of physics is due to the abstract and difficult to observe physics concepts [3]. The scope of physics concepts that are in the microscopic world (quantum physics) or the speed of objects approaching the speed of light, makes it difficult for students to imagine the concept.

Learning media that is able to visualize abstract physics concepts is 3D media with Augmented Reality technology [4]. Augmented reality uses a 2D marker that can display 3D objects when scanned using a smartphone camera [5]. However, the availability of 3D media with augmented reality is still rarely developed, especially on the topic of quantum physics and modern physics. Augmented reality is very suitable to be used as an interactive and real learning media directly by students [6,7]. In addition, learning media using Augmented Reality can increase students' interest in learning because of the nature of Augmented Reality, combining virtual worlds that can increase students' imaginations with the real world directly.

One of the abstract modern physics concepts is black body radiation [8]. Students have not been able to explain the phenomena that occur and only learn the formula for black body radiation. Real experiments on black body radiation are also rare in everyday life. A black body is an object that absorbs all electromagnetic radiation that comes to it, so that no radiation is emitted or reflected.

Solar radiation is the emission of particles originating from thermonuclear processes that occur in the sun. Solar radiation in the form of electromagnetic radiation that propagates in the form of waves or particles. Electromagnetic radiation as a particle can be explained by counting the radiation emitted by photons, while electromagnetic radiation as a wave can be explained by the phenomenon of interference.

Sunlight that enter the earth have various wavelengths. Visible light has a wavelength of 400-700 nm, red light is above 700 nm, and UV light is below 400 nm. The total amount of radiation received at the earth's surface depends on the distance from the sun, radiation intensity, sun duration, and atmospheric influences.

The props developed by Amin [9] have been able to obtain the wavelength of the color spectrum at intervals corresponding to the Wien constant obtained around 2.56 x 10-3 mK. The Wien constant obtained has an error of 23%. The experiments carried out get values that are far from the theory. Therefore, in this study, Stellar Augmented Reality will be developed to visualize the Wien's Displacement phenomenon.

Methodology

The type of research conducted in this research is the type of research and development or Research and Development (R&D). The product developed is an Stellar Augmented Reality to visualize Wien's Displacement. The development model used in this study is the Presman waterfall software development model is presented in the Figure 1 which has 4 development stages, namely, the analysis, design, coding, and testing stages.

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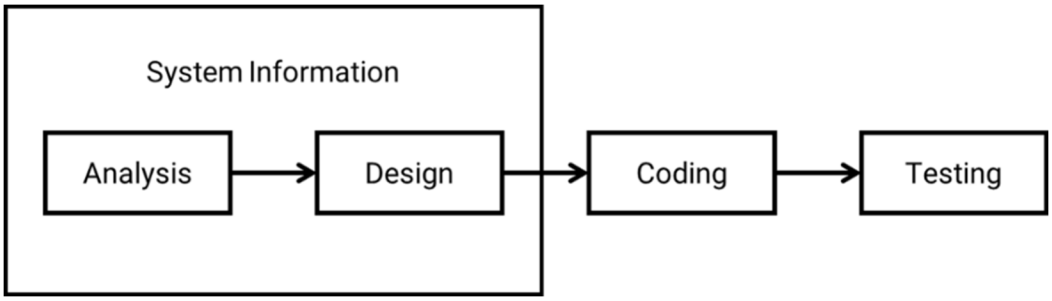


Figure 1. Waterfall development model according to rosa [10]

At the analysis stage, the data/information needed to be collected are collected to solve problems in learning physics. The analysis stage includes the material requirements analysis, user needs analysis and software analysis. The results of the analysis are then used as guidelines for carrying out the design stage. The results of the design stage are then translated into a program at the coding (implementation) stage. At this coding stage the development of learning media uses Unity 3D 5.3 software. The results of the implementation stage in the form of stellar augmented reality. To determine the quality of stellar augmented reality, software testing was carried out. Tests are carried out through black box tests and feasibility tests by media experts and users.

Research on the development of stellar augmented reality was conducted at the Department of Physics, Universitas Negeri Malang. The subjects in this study were Tadris Physics lecturers, UIN Antasari Banjarmasin and Physics Department lecturers, Universitas Negeri Malang as media experts, and physics education students of Universitas Negeri Malang as users. The techniques used to collect data in this study include: (1) Open observation is used at the observation stage to obtain an initial picture, (2) Unstructured interviews were used to find out what information is the problem on the topic of Wien's Displacement, (3) black-box testing was used to test application functionality, and (4) questionnaires were a data collection technique using questionnaires in the process. Based on the data obtained, the eligibility criteria of stellar augmented reality were determined using the criteria from Arikunto [11] and the practicality criteria were determined using the criteria from Yamasarini [12].

Results and discussions

The result of this research and development is Stellar Augmented Reality which runs on the Android platform. Stellar Augmented Reality was developed according to a planned procedure. In the material requirements analysis stage, the topic of physics in high school is obtained. In addition, the important things obtained from the observation and interview process at the analysis stage are, (a) abstract physics material causes difficulties for students, (b) teachers tend to only explain theories and formulas, (c) students tend not to pay attention, are noisy and like to play cellphones. (d) students are more interested in visuals, (e) most students have Android phones. At the analysis stage, the results obtained are suitable media specifications to be developed.

The design stage is carried out based on the needs analysis that has been carried out. The stellar augmented reality design is presented in the Figure 2.

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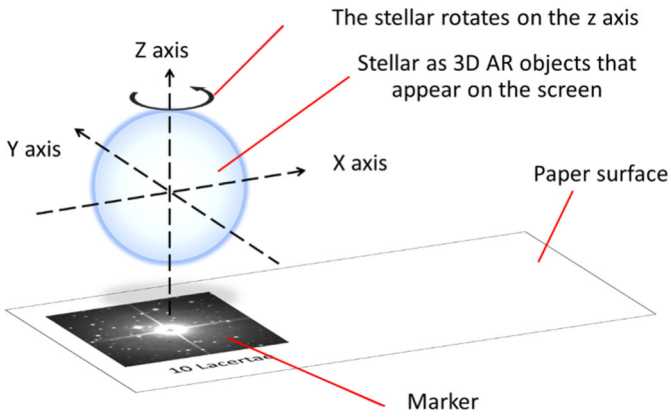


Figure 2. The stellar augmented reality design

We use the data in the table to generate the wien's displacement phenomenon in stellar augmented reality.

Table 1. To format a table caption, use the Microsoft Word template style: Table Caption. The text

Class	Effective temperature	Vega-relative chromaticity	Chromaticity (D65)	Examples
O	≥ 30,000 K	blue	blue	10 Lacertae
B	10,000 – 30,000 K	blue white	deep blue white	Rigel
A	7,500 – 10,000 K	white	blue white	Sirius A, Vega, Deneb,
F	6,000 – 7,500 K	yellow white	white	Polaris, Canopus
G	5,200 – 6,000 K	yellow	yellowish white	9 Pegasi, Matahari
K	3,700 – 5,200 K	light orange	pale yellow orange	Pollux, Arcturus, Aldebaran
M	2,400 – 3,700 K	orange red	light orange red	Proxima Centauri, Betelgeuse

The stellar Augmented Reality design was further developed using Unity 3D software and the Vuforia SDK with the application scheme presented in the Figure 3.

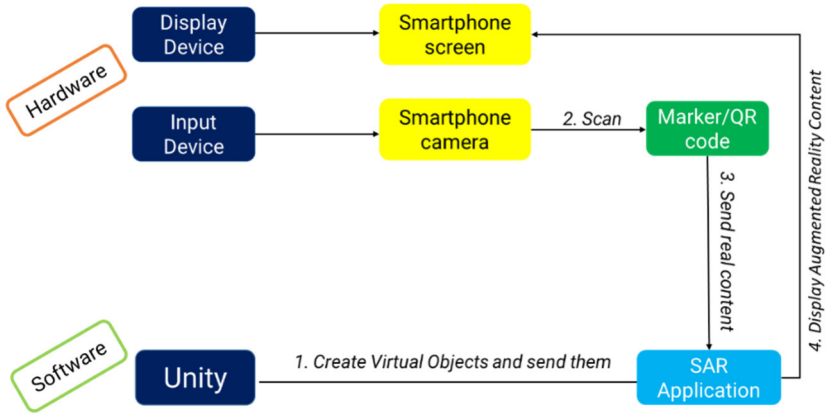


Figure 3. Application scheme

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Unity 3D is integrated software that can be used to create games, building architecture, and simulations. Vuforia is an Augmented Reality Software Development Kit (SDK) for mobile devices that enables the creation of AR applications. The Vuforia SDK is also available to be combined with Unity, namely the Vuforia AR Extension for Unity. At the coding stage, a custom script is created to display the application. The result of the coding stage is stellar augmented reality.

Stellar augmented reality can be used by downloading the scanner application via https://bit.um.ac.id/arfmipa22. After downloading and installing the scanner application, scan the marker on the Figure 4. to be able to see stellar augmented reality.

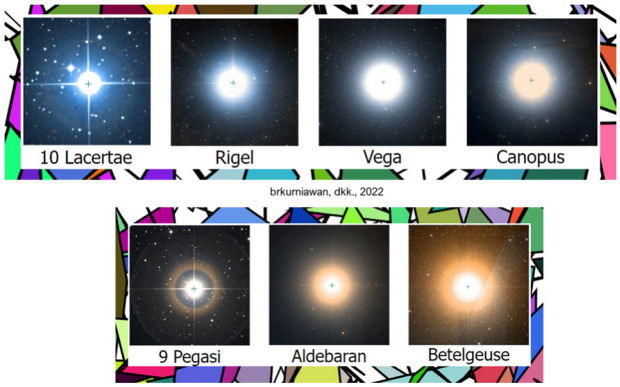


Figure 4. Stellar augmented reality marker

The resulting stellar augmented reality is presented in the Figure 5.

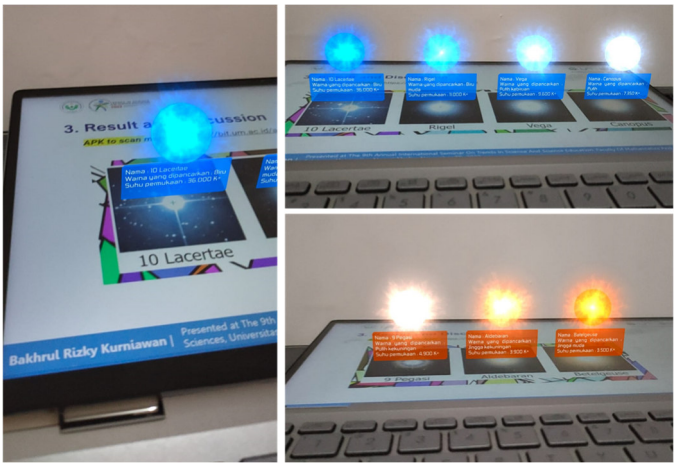


Figure 5. Stellar augmented reality

The testing stage is black box testing and validation test. Black box testing is used to test the performance or functionality of the developed software application. The validation test in this research and development involved two media experts. The validation results produce assessments, comments and suggestions which are then used as a reference for improving learning

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media before being tested on users. The media expert validation test consists of media design aspects, appliction aspects, and usability aspects. The results of the validation by media experts can be seen in the table below.

Table 2. The results of the validation by media experts

No	Aspect	Average Score	Eligibility Criteria
1	Media design	83.33	Very eligible
2	Application	87.50	Very eligible
3	Usability	87.50	Very eligible
	Average	86.11	Very eligible

In Table 2, it can be explained that the validation carried out by media experts on Stellar Augmented Reality found that the average score of the media design aspect was 83.33 with the "Very Eligible" category, the application aspect got a score of 87.50 with the "Very Eligible" category, the usability aspect got a score of 87.50 with the "Very Eligible" category. And the total average score of the media as a whole obtained is 86 with the "Very Eligible" category. The media expert validation data is presented in the form of a bar chart as shown in the Figure 6.

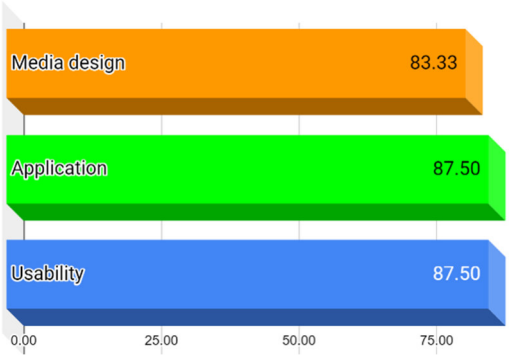


Figure 6. Validation result

After being validated by media experts, stellar augmented reality was then corrected according to expert comments before being tested on a limited trials to 20 students of physics education at the Universitas Negeri Malang. User response tests were conducted to determine the practicality of stellar augmented reality products. The user response test results get a score of 80 so that the practicality criteria for Stellar Augmented Reality are practical

Overall, Stellar Augmented Reality has received a positive response from both validators and users. Users are very happy and enthusiastic about learning by using visual aids such as augmented reality. Users hope that more will develop augmented reality to visualize abstract phenomena. Besides that, the user also hopes that later the user can vary the amount in augmented reality.

Conclusion

This research and development have developed stellar augmented reality to visualize wien's displacement. The resulting product is a 3d design, scanner application and marker to display

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augmented reality. The results of validation and limited trials show that stellar augmented reality is categorized as very eligible and practical. The use of stellar augmented reality to visualize wien's displacement has received a positive response from validators and users.

Acknowledgements

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Development of computer-assisted interaction diagrams to improve student's understanding of newton's laws

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Abstract. *Newton's Law cannot be taught with current instructional technology without experiencing a number of problems, including diminished interaction, ineffective drawing time, inaccurate scale, and inability to teach students how to draw properly. As a result, students struggle to create interaction diagrams, and bits of student knowledge start to surface. Our research intends to create a motion dynamic learning package with computer assistance. The ADDIE model serves as the foundation for our research and development processes (Analysis, Design, Development, Implementation, and Evaluation). The validity test is rated as very good based on the findings of the media development project. The necessity of adjusting the weight on the block, the function of the ruler on the arrow, force type symbols, and the addition of some attributes to make it more contextual are just a few examples of the things we do in response to suggestions from practitioners and experts (rope, table, etc.). A companion module is also included in the motion dynamics learning package to help instructors teach interaction diagrams effectively and thoroughly.*

Keywords: computer-assisted, interaction diagrams, newtons law whiteboard magnetic, dynamics motion

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Introduction

The development of modern science cannot be separated from Newton's laws of mechanics. Newton's laws of mechanics are basic subject matter consisting of three interrelated laws to explain how objects move [1-2]. This concept serves as a suitable initial momentum to challenge the naive intuition that students bring to the classroom.

According to several studies, students' knowledge of Newton's law principles was still weak. Even high school students retain their misconceptions; some may carry them to college [3]. Not to mention how teachers and student textbooks often refer to "action-reaction force," which furthers misunderstandings and makes it more challenging for students to understand Newton's laws [4]. In order to avoid having a disjointed knowledge of topics, students need to be taught how to employ causal reasoning [4,5]. One of the causes is that students can draw free body diagrams well [6-8].

Drawing force diagrams is an expert student's tool for resolving complicated issues [9], and this skill is developed via practice. These abilities can be utilized to create software that analyzes the forces affecting formula racing automobiles [10]. However, students have struggled due to their inability to recognize forces that operate directly vs indirectly, disregard for direction, incorrect use of force, and lack of attention to action points [11].

There have been advancements made to help students create force diagrams more effectively. Magnetic disks, solenoids, and mechanical equilibrium were utilized by Panijpan et al. to show that magnets may stay stationary when suspended in the air. Such that it can refute students' assumptions that a stationary object is not subject to any forces [12]. The interaction of forces can be demonstrated using a pair of dynamometers with two flexible plastic strips attached to them, as opposed to the straightforward experimental equipment created by Scomparin and Neto [13], These two inventions, however, do not directly display force diagrams on demonstration equipment. Students may benefit from practising their ability to make stylistic diagrams using a computer and a magnetic board.

Newton's laws have long been taught to students using computer technology [14]. A internet learning management system with animated force diagrams and feedback for engineering students was created by Roselli et al. specifically for teaching students how to make force diagrams [15]. The effectiveness of student-force diagram sketching has also been evaluated using software that provides immediate feedback [16]. Recently, a program with an intelligent interface was created to automatically grade force diagram sketches in the course work of engineering students [17]. However, this program did not employ a method that would have helped senior high school enhance their skills.

In earlier research, we developed a magnetic whiteboard. The amount of time it takes students to draw force diagrams has decreased because to new developed media. However, it is still extremely likely that people would have misunderstandings concerning Newton's laws. Therefore, this research is a continuation of our earlier initiatives to develop computer software to be used with magnetic whiteboards. Additionally, this study incorporates three illustrations that are successful in dispelling misconceptions about constructing force diagrams and using Newton's principles [18]. A meaningful interaction diagram (MID) is the end result of combining the three forms. Our research question: (1) How is the development of computer applications to improve the skills of drawing force diagrams with meaningful interaction diagrams?; (2) How is the

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feasibility of a computer application to improve the skills of drawing force diagrams with meaningful interaction diagrams?

Methodology

The type of research conducted in this study is Research and Development (R&D). The media developed in this study is computer assisted of MID that will be used to improve students' conceptual understanding and interaction diagrams drawing skills to develop a magnetic chart on particle dynamics material. The design of the study is ADDIE design which consists of a few steps: Analyze, Design, Develop, Implement, dan Evaluate [19]. The flow chart of these steps can be seen in Figure 1.

In the first stage, an analysis of students' understanding of the particle dynamics material and an analysis of appropriate learning media to solve the problem is carried out. The outcomes of the analysis are then utilized to design a media development strategy in the second step. We place a premium on properly specified media development goals. The process consisted of designing the story board, and constructing the instrument of validation test. The resulting media is being demonstrated before lecturers and teachers to represent experts and practitioners in the next stage. The validation test is carried out. The result of the validation test is being analyzed and evaluated.

The validation test involved a lecturer and two physics teachers. The instrument of the test consisted of 2 types of questionnaires which are closed questionnaire and open questionnaire. A closed questionnaire measures the suitability of the statements of the indicator with the media itself. The scale that we used to indicate the suitability is a 1-4 Likert scale which scale one represents not valid and scale 4 represents very valid. An open questionnaire used to get a suggestion from the validators, and the result was being analyzed qualitatively.

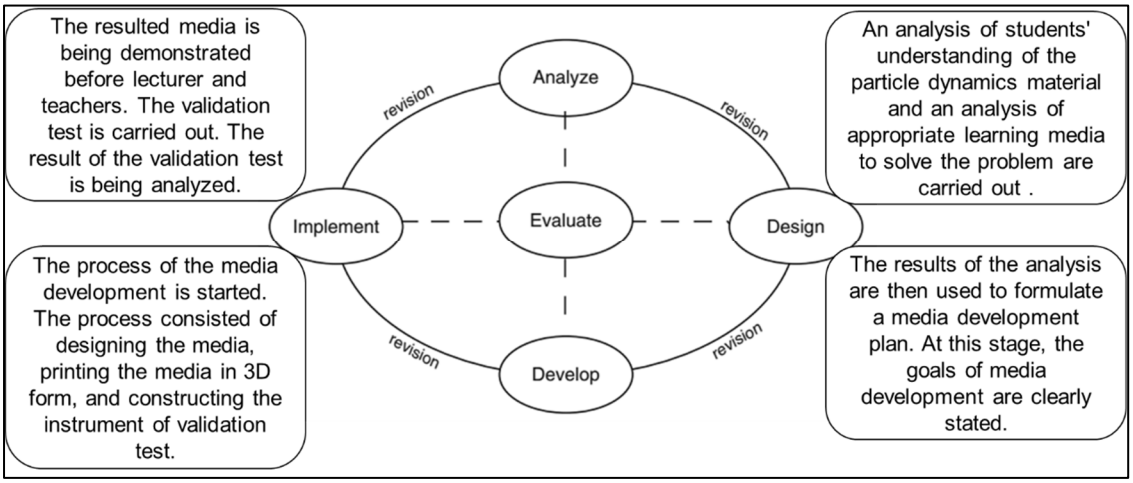


Figure 1. Flow chart of the research and development stages

Results and discussions

The author began with field research that included observation activities on motion dynamics and interviews with physics and science teachers. Several observations we made, such as the scarcity of media in schools and the absence of an engaging and dynamic learning process, served as the first parameters for developing media requirements analysis tools. Following that, we developed

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and validated a questionnaire for conducting a needs analysis. The questionnaire was delivered online using Google Forms. The preceding post discussed the results of our needs analysis (Kurniawan, et al, 2021). Teachers and students are aware of the problems associated with learning FREE-BODY DIAGRAMS due to the learning media's constraints, the length of time required to draw, the lack of interaction, and the scale's accuracy. Additionally, the cost is a disincentive for teachers and students to choose animation over alternative solutions. Thus, by incorporating magnets into the whiteboard, magnets are an effective and more economical option.

We define the shape and size of the FREE-BODY DIAGRAMS media to be created during the design stage. To begin, we define the force type, the object shape, and the media colour. There is six distinct force with varying lengths and hues: Normal Force, Weight, Tension, Friction, and Gravitation. We also develop 24 questions of FBD.

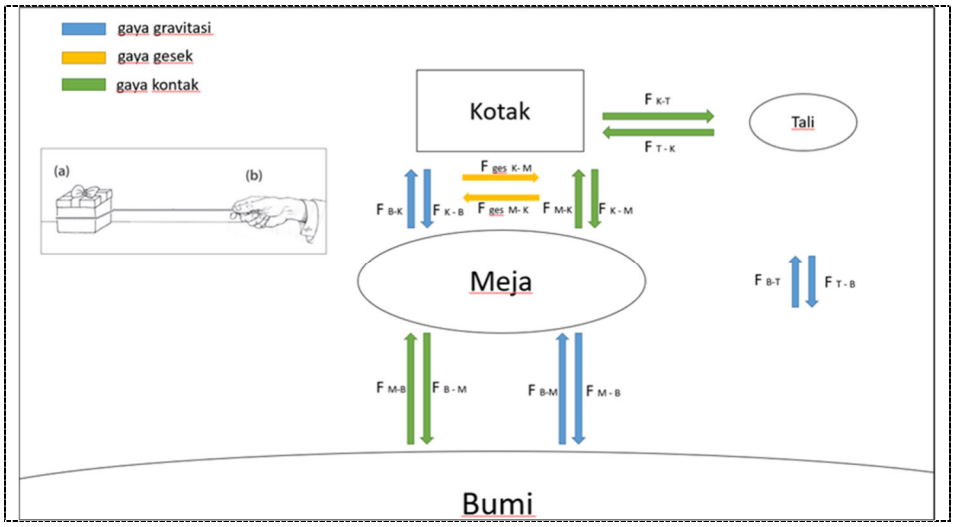


Figure 2. Design of case 1 meaningful interaction diagrams

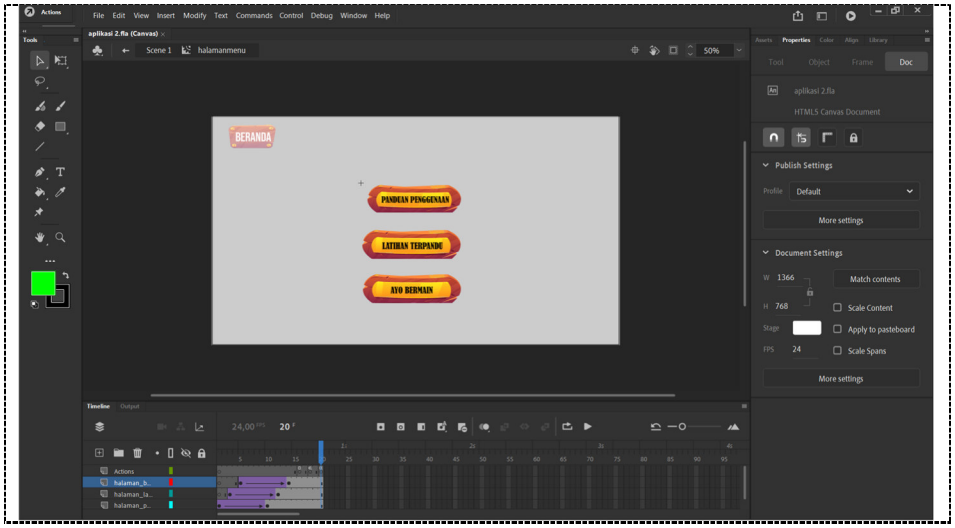


Figure 3. Development of main menu

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After the design is complete, during the development stage, we develop an HTML5 type application using Adobe Animate. There are three main menus namely usage guide, guided practice and let's play. Coding using the drag and drop feature as the main game to train students to design diagrams can be seen in Figure 4.

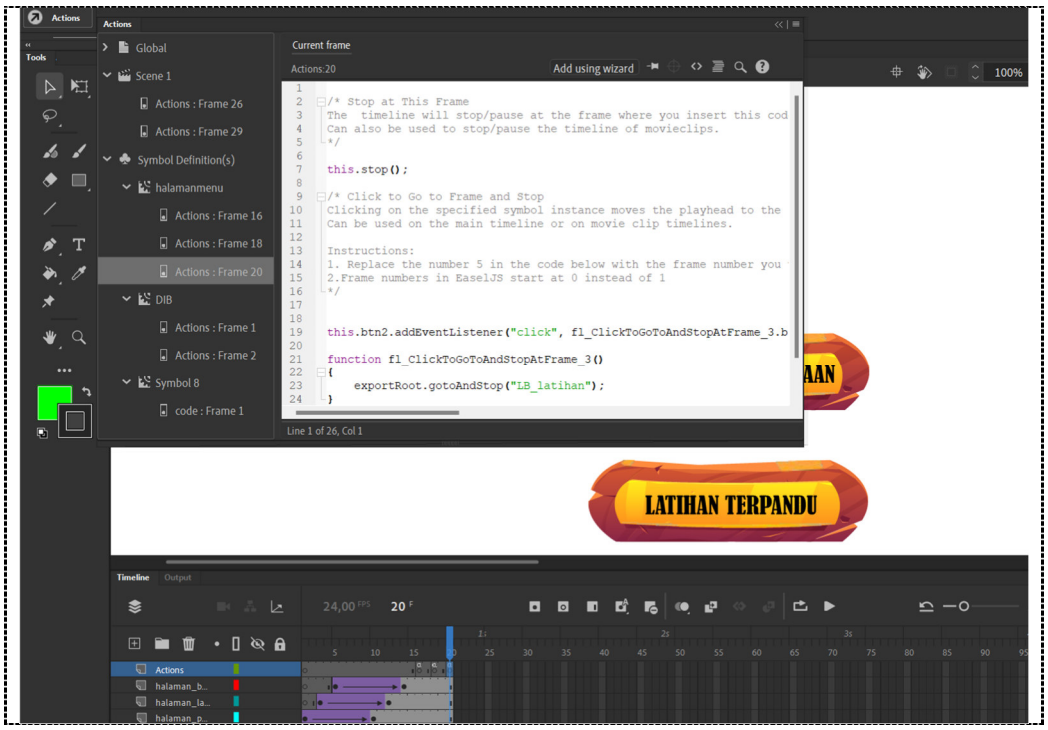


Figure 4. Action script

The content, constructs, and claims were then validated by one physics education lecturer and two physics teachers with 31 and 3 years of teaching experience, respectively.

Table 1. The Results of content validation

Category	Value
Accuracy of physics concepts and principles in media	3,67
Conformity to the curriculum	3,33
Suitability to students' cognitive level	3,67

Table 1 summarized the findings of content validation, which included three components: idea correctness, curriculum conformance, and students' cognitive level with regard to media usage, with an average of 3.56.

The findings of concept validation using two indicators, namely language, and design, are shown in Table 2. Both metrics also demonstrate the validity of the produced media.

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Table 2. The Results of Construct Validation

Category	Value
Language	
The suitability of the sentences used in the instructions for using the media with good and correct linguistic rules	3,67
The clarity of the sentences used in the media usage instructions so that they are easy to understand and do not have double meanings	3,67
Design	
The suitability of the shape of the media components as a representation of the free body diagram symbols	3,67
Consistency in color of media components within each force	4
Utilization of proportionate media sizes to ensure visibility from a certain distance	3,33
The design facilitates the media's use in accordance with its function.	3,67
The design of the media makes it attractive to use.	3,67

Additionally, we claim numerous categories that demonstrate the validity of the media we have constructed. Additionally, experts and practitioners concurred. Table 3 summarizes the findings.

Table 3. The Results of Claims Validation

Category	Value
Components of the media are easily moveable	4
The media components are sufficiently complete to enable the visualization of a free body diagram.	3,67
The use of media in education has the potential to increase teacher-student interactions	3,67
The media acquaints students with force symbols	3,67
Media can help students enhance their ability to create diagrams interaction	3,67
The media is more precise in educating students about the forces that operate on objects.	3,67

The most intriguing part of the validation process is when validators express their replies openly since we believe this contributes more to the development of ideas than merely quantitative findings. Table 4 summarizes the public answers from our experts and practitioners.

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Table 4. The Results of Open Questions

No	Open Suggestions
1	By adjusting the weight on the block, students may learn to distungish between normal and applied forces
2	Present more complicated illustrations, such as a person pushing a table. More complex problem
3	Provide a hard level!, students try move one by one!

Firstly, the validator advised varying the mass of the block to allow students to experience determining gravity. Students can also practice finding the resultant normal force by applying the force from the top of the block. More realistic pictures incorporating human items and others at a lower level are required for junior high or elementary school. Secondly, the role of symbols in learning physics cannot be separated. After the seventeenth century, physics took on a new quantitative dimension. The addition of the symbols for force, mass, and acceleration enable students to grasp mathematics's symbols and meaning while studying physics [20].

The use of drag and drop in learning applications is familiar to students. De Jong, et. al [21] developed a virtual laboratory application where students can drag variables into the columns provided. In theory, interactive media put forward by Sundar, et. al that the features on the application affect the involvement and interaction of individuals [22]. Human interaction with computers will vary depending on the application features. We provide different levels in each case to match the level of students' initial knowledge.

Conclusion

We have developed a computer application for learning dynamics of motion media that can run HTML5. At the media validation stage, one lecturer and two physics teachers stated that the computer application media was valid. We have corrected several suggestions regarding accuracy, force variations, and the addition of symbol and illustration components to make them look concrete in line with these suggestions.

Acknowledgements

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Development virtual laboratory based on augmented reality for basic concept of physics and chemistry course for elementary teacher student

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Abstract. *The last Elementary School Teacher Education Lecturer Association Meeting (HDPGSDI) meeting in 2020 recommended that the Basic Concepts of Physics and Chemistry courses are new courses that have begun to be implemented as the development of the Merdeka Learning Independent Campus (MBKM) curriculum. The learning achievement of this course is that students are able to understand theories, concepts and procedures regarding Physics and Chemistry events that occur in everyday life. To achieve this, students are required to do some practical work related to the material given in this course. The pandemic condition due to the Covid-19 virus, which has not yet ended, requires learning at Medan State University to conduct Blended Learning. This of course has an effect on all learning activities by still applying online for 50% of elementary school teacher education students (PGSD) who take the Basic Concepts of Physics Course. Researchers have developed a virtual laboratory based on Augmented Reality to conduct practical work on the Basic Concepts of Physics and Chemistry at the PGSD FIP Unimed Study Program. The development of a practicum guide will also be carried out as a learning tool using the Research and Development (R & D) method which in this study will be carried out to the stage of perfecting the initial product. The scientific attitude and motivation of students after using the practical guide in this virtual laboratory measure the picture of the effectiveness of learning and the projection of future IT/ICT media-based research. This research will produce an e-module practicum guide and will be disseminated in the form of an ISBN module, indexed international proceedings articles, accredited national journals and will also be registered as intellectual property rights (HaKI).*

Keywords: virtual laboratory, augmented reality, research and development method

Introduction

The Covid-19 pandemic that has hit the world since 2019 has had an impact on the daily activities that we usually do, including educational activities. Restrictions on community activities carried out by the government on face-to-face learning (FTFL) in schools require teachers, who incidentally are educational successors at the school level, to continue to develop in the midst of this situation and continue to provide quality learning for students. One of the steps taken is to

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apply e-learning based learning which is considered quite successful in surviving this situation [7]. Apart from being quite flexible to implement, e-learning-based learning is also quite successful in attracting students' interest in the learning being carried out [11]. E-learning based learning can also be an option to accommodate learning through laboratory rooms, especially science laboratories. Limited learning activities and incomplete experimental tools in school laboratories, which have often been a problem, can be easily solved by e-learning based learning.

We made initial observations through a questionnaire which was distributed to 106 respondents from semester 1 PGSD FIP Unimed regarding laboratory learning in schools/campuses. Based on these data (**Figure 1**), as many as 34% of respondents acknowledged that there were still those who had never conducted experiments in a laboratory at all for various reasons.

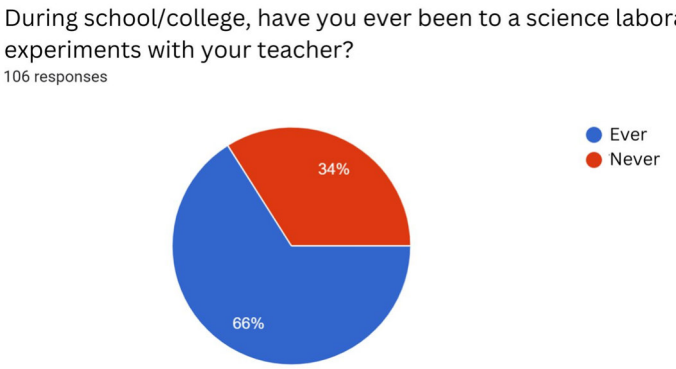


Figure 1. Initial observastion researchs of PGSD FIP UNIMED students

Based on (**Figure 2**) as many as 77.1% of respondents said that the limited laboratory equipment and the absence of laboratory rooms in schools/campuses were the main problems. Thus, researchers consider the use of virtual laboratories will be able to overcome these limitations.

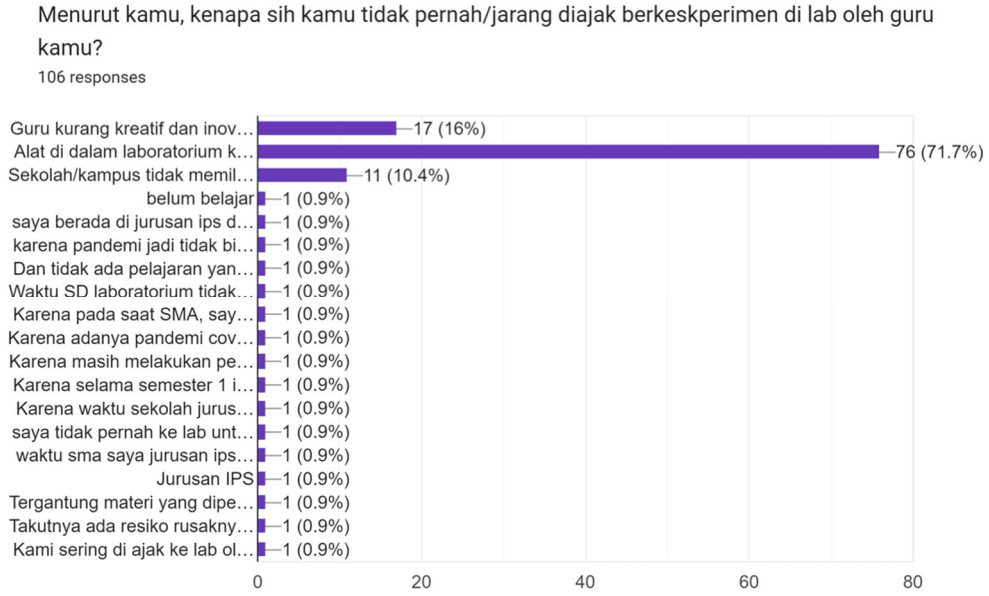


Figure 2. PGSD Student Responses to Reason Never Doing Practicum in Laboratory

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Today, the use of e-learning in the teaching and learning process has also attracted the interest of researchers in the field of educational technology to continue to develop various learning media and applications for students. One way is to use a combination of reality and cyberspace, called Augmented Reality, which is currently being used in Indonesia even though its use is not as massive as abroad [4]. AR is a potential that has great opportunities in science and technology because this science technique displays attractive visuals in 3D and animation, and emphasizes practical training in real time [3]. Using AR allows students to learn in a different and unique way because they can be directly involved in the learning.

In recent years, AR technology has begun to be applied to the world of education and training as a potential alternative media in current teaching and learning activities. However, the potential for using AR in learning still needs to be further developed so that its application in the learning process, especially learning with virtual laboratories, can be carried out properly.

Basic Concepts of Physics and Chemistry taught to PGSD students through experimental methods in virtual laboratories. The use of Augmented Reality-based virtual laboratories can be simulated and implemented by creating 3D objects and animations, so that students can interact with objects directly through virtual applications.

In its application, AR can also succeed in implementing learning through experiments in the laboratory room. The real situation in the laboratory can be easily transferred to student devices through virtual reality, so that the limitations of tools in school laboratories are expected to be solved through Augmented Reality media.

Methodology

The content of Module developed includes 7 main chapters which will be redeveloped based on sub-chapters which contain explanations and applications of the interrelationships of concepts contained in Physics and Chemistry in PGSD. There are 7 science chapters that will be developed to the Physics and Chemistry concepts such as Quantities, Unit and Measurement, Force and motion, energy and their changes, sound, temperature and heat, electricity and magnetism, earth. and universe materials to be developed will follow the design using the R & D-based approach as follows:

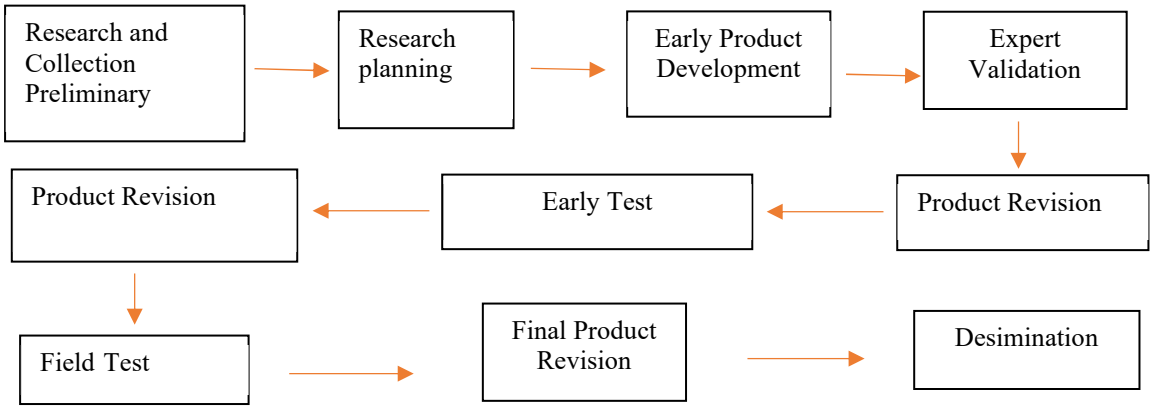


Figure 3. Design e-module practicum guide

The learning device development model which will be used in this study is a Research and Development (R&D) model often interpreted as a process or steps to develop a new product. The

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steps of research and development (R&D) according to Borg and Hall (1989: 775) are a) Research and Data Collection, b) Planning, c) Initial Product Development, d) Initial Product Trial / Limited Trial, e) Refinement of Initial Products, f) Wider Field Testing, g) Improvement of Product Results of Wider Field Tests, h) Final Product Trials, i) Revision or Refinement of Final Products, j) Dissemination and Implementation. In this study the steps used are only at the initial product refinement stage.

Result and Discussion

Module design The basic concept of science based on IT / ICT media is an alternative in online learning so that students can receive basic science concepts directly with the help of IT /ICT media and show that technology helps these students to increase their confidence in terms of attitude, motivation, and the social environment. The module developed with this teaching material will also trigger positive perceptions of PGSD students on the basic concepts of science so that they do not experience misconceptions on some basic science concepts and online learning is applied to be more efficient.

This research uses IT / ICT based media. These media utilize several learning media such as Virtual Laboratory based *Augmented Reality* (AR). The IT / ICT media-based module is filled with material that provides a lot of explanation regarding the basic concepts of science and displays media that can be accessed easily by simply scanning the barcode on the desired material in the module, the module design is:



Figure 4. Display e-module practicum guide

The purpose of this study was to determine the optimization of online learning on the basic concepts of Physics and Chemitry. In this study, the average conceptual understanding of PGSD students in class K was 85.7, the highest score achieved was 90 and the lowest was 75 so it was included in the very good category (Arikunto, 2012). Based on the research, students' responses to the module were obtained from four aspects of the response, student experiences in the laboratory, mastery of concepts, learning motivation, and impact learning science with Augmented Reality

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(AR). Following are the student's responses to the module display, mastery of the module concept, the response to learning motivation and the response to impact learning science with Augmented Reality (AR) :

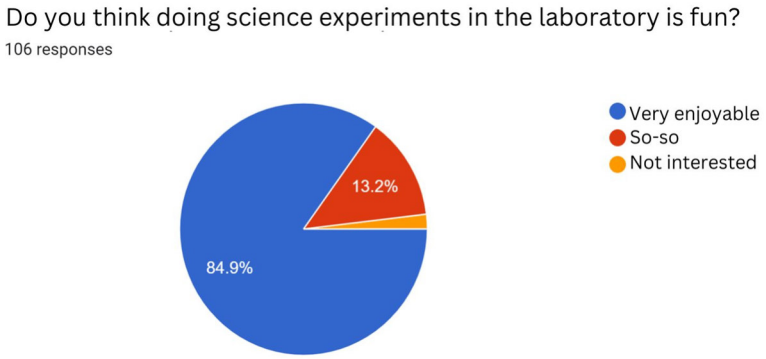


Figure 5. PGSD student response experiences in the laboratory

Based on the pie chart above, the highest student response was obtained in the very enjoyable category, which was 84,9 % and 1,9 % of students answered that the display of teaching materials was not interested.

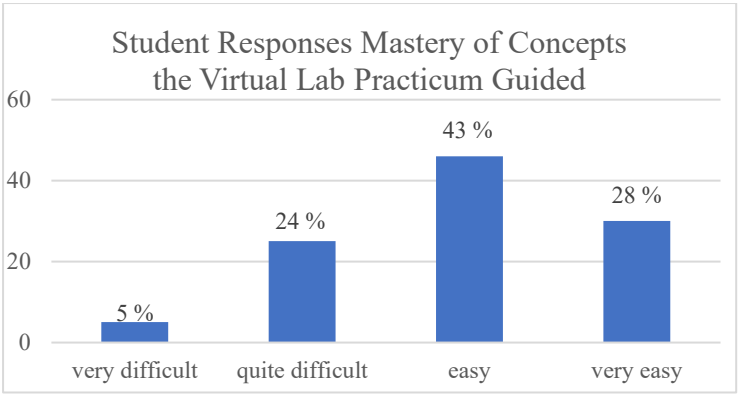


Figure 6. PGSD student responses mastery of concepts with virtual lab practicum guided

Based on the graph above, as many as 43 % of PGSD students responded that the teaching materials developed were easy to understand and as many as 5 % with responses were very difficult to understand.

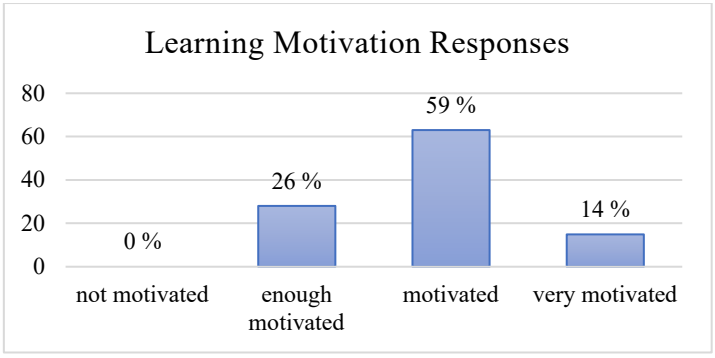


Figure 7 PGSD Student Responses to Learning Motivation for Teaching Materials

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Based on the graph above, the highest student response is obtained in the Motivated category, which is 66% and as many as 0% of students feel unmotivated towards the teaching materials developed.

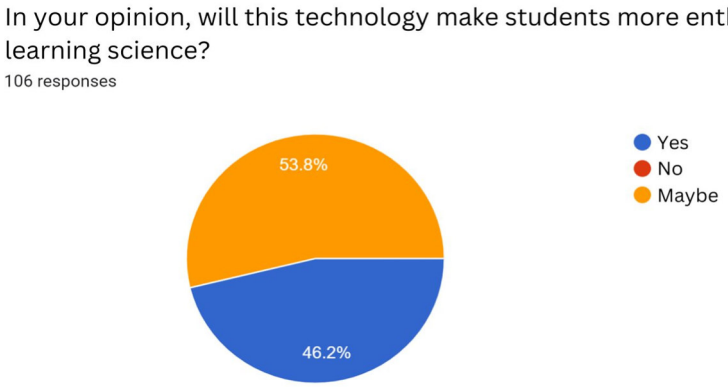


Figure 8. PGSD student responses to the impact learning science with AR

Based on the pie chart above, as many as 46,2 % of PGSD students gave enthusiastic responses to obtain learning science, although there are still quite a large number of students who are hesitant to use AR because they are not familiar with them but as many as 0 % negative responses based on the teaching materials developed.

After the practicum guide were tested, the average PGSD students showed quite positive responses to the practicum guide developed. Based on the concept understanding response, only 1,9 % of students considered that the practicum guide was not attractive, 3% considered that the practicum guide was difficult to understand, 0% considered that the practicum guide did not motivate them in learning, and 3% considered that the practicum guide was not attractive in obtaining information. This relatively small percentage indicates that the practicum guide developed give a positive perception to the majority of PGSD students.

Based on the results of the development of practicum teaching materials, it shows that it is important to teach physics and chemistry using practicum in order to avoid misunderstandings in understanding the material. This is in line with the results of research by several researchers [2,12]. In addition, an understanding of the content of the material used in learning affects students' perceptions and motivation in the learning process (Morales & Baker, 2018; Sigman, 2019)

The average score based on the questions tested also showed a satisfactory score of 87.6. This shows that PGSD students have been able to answer questions on Basic Physics and Chemistry concepts well. The questions being tested are questions about the basic concepts of Physics which are related to everyday life.

Conclusion

Based on the development of teaching materials for the basic concepts of physics and chemistry for PGSD FIP Unimed students through practicum using a virtual laboratory based on Augmented Reality, it was found that there was an increase in conceptual understanding and student motivation in following the basic concepts of physics and chemistry courses. The application of science practicum using a virtual laboratory based on Augmented Reality provides a learning experience for students.

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Implementation of project-based active learning to improve occupational safety and health competencies for automotive engineering education students

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Abstract. *Occupational Safety and Health (OSH) is an important course needed to provide work safety experience that supports every job to create workers to carry out their work effectively, comfortably, safely, healthily, and efficiently, and to avoid accidents due to work. The OSH teaching tends to focus on theoretical material enrichment, resulting in a monotonous one-way learning atmosphere minus the interaction between lecturers and students. This study aims to develop and implement project-based active learning to improve OSH competence in automotive engineering education students. This study involved 84 students of the Automotive Engineering Education Study Program, Department of Mechanical Engineering Education, Faculty of Engineering, Universitas Negeri Medan. The research was conducted through the development of project-based learning resources for teaching OSH according to the needs of automotive engineering education students, standardizing and implementing them in the classroom. The results show that project-based learning resources guide students in active learning, starting from identifying work safety problems, analyzing potential hazards, and controlling work safety risks in order to prevent or resolve work safety problems that occur in the field such as SMEs. The results of observations on project assignments showed that students completed project assignments well, and subjective scores (M=82.10±8.72) were high. Student learning outcomes in the OSH course (M=88.56±7.14) are in the very good category, namely the competence in the field of work safety has been achieved. Observations show that students are motivated to learn actively, and project assignments have proven to be effective in achieving their competence in the field of OSH. It is hoped that project-based learning can also be applied to other courses in the Department of Mechanical Engineering Education.*

Keywords: project-based learning, occupational safety and health, learning outcomes

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Introduction

Active learning is very appropriate to be implemented in universities for teaching engineering because students already have autonomy in learning, mature in thinking, and can adjust their abilities to achieve competencies according to the needs they are learning [1]. Various types of active learning such as discussions, problem solving, case studies, projects, role plays, and other methods have been shown to be effective in increasing knowledge and skills in adult learning. Innovative learning is a good strategy in achieving the competence of automotive engineering education students [2]. One of the compulsory subjects in the Automotive Engineering Education Study Program is Occupational Safety and Health (OSH). OSH courses are very necessary to provide work safety experience that supports every job to create workers to carry out their work effectively, comfortably, safely, healthily, and efficiently, and to avoid accidents due to work [3,4]. The problem faced is that it is difficult to facilitate active students in learning OSH because they have to combine knowledge, skills and safety awareness [5]. Learning problems caused by the Covid-19 pandemic since 2020 add to the difficulty of achieving OSH competencies because learning is carried out online to break the transmission of the corona virus [6]. To overcome this problem, project-based learning that is adaptive to learning by learning independently is needed [7,8]. Various strategies can be carried out such as implementing teaching and learning strategies, selecting appropriate learning models and methods, and innovating learning [9-11]. To optimize the implementation of project-based learning, it is necessary to provide innovative learning resources in accordance with competency targets, which can guide students to study systematically, carry out their own projects, and create an atmosphere of learning and teaching that takes place holistically in increasing the knowledge and skills required in the courses required studied [12,13].

Knowledge of occupational safety and health is an important field of knowledge to be understood and applied by students in carrying out their work. This knowledge needs to be studied so that it can be applied as an effort to prevent accidents and occupational diseases that may occur in every line of work, both in small industry, large industry, and in service work such as education [14,15]. The learning of Occupational Safety and Health courses at the Mechanical Engineering Education Department is carried out for first year students to provide proper knowledge and understanding regarding the importance of occupational safety and health before carrying out practical activities [16,17]. Thus, efforts must be made to make the teaching and learning process run well by adjusting class conditions to optimize student learning potential to achieve competency targets. This study aims to develop and implement project-based active learning to improve OSH competence in automotive engineering education students.

Methodology

The study was conducted following the research procedure described previously with modifications according to the characteristics of the Occupational Safety and Health course [18,19]. In general, the research method includes the population and the sample and the research procedures are briefly described below.

Population and sample

The research was conducted in the even semester of the 2021/2022 academic year, namely through blended learning for the application of health protocols because it is still in the transition from the Covid-19 pandemic to the normal period. The research population was students of the Department

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of Automotive Engineering Education, Faculty of Engineering (FT), Universitas Negeri Medan, involving 84 undergraduate students. The implementation of this research has complied with the code of ethics for social research in the field of education set by the University. Students were given an explanation about their participation in the sample in the implementation of research, namely project-based learning. Student participation is ensured by filling out a consent form, and they are given the freedom to withdraw at any time if necessary without affecting their academic assessment.

Research Procedure

The research procedure consists of developing learning resources, standardization and implementation for teaching Occupational Safety and Health (OSH) courses. Developing learning resources for Occupational Safety and Health courses is intended for learning to meet the achievement of OSH competencies, which is carried out through enrichment of teaching materials in accordance with the competency-based curriculum oriented to the Indonesian National Qualifications Framework (INQF or KKNI), integrating project assignments and supporting tools according to the needs of students based on targets curriculum.

Standardization of learning resources is carried out using experts, namely external lecturers and internal lecturers who have understood and implemented OSH. They were asked for their opinion on the appropriateness of the content of the OSH material and its supporting projects that have been prepared in the learning resources. Several parameters of the feasibility component of learning resources for OSH courses were asked to respondents, and their opinions were used as input for revising and perfecting OSH resources into innovative learning resource packages. The Likert scale was carried out to assess the opinions of respondents who were netted using a questionnaire with 4 choices, namely using the assessment criteria from the strongest (4) Very Appropriate to the lowest (1) Very Disagree.

Implementation of learning resources in OSH teaching is a very important stage in this research. All stages of learning are carried out following learning at the Faculty of Engineering, Universitas Negeri Medan. Sequentially, teaching is carried out through the provision of basic OSH theory in blended learning, which is a combination of face-to-face lectures and online lectures using zoom or google meet for consideration of learning variations. Furthermore, an explanation of the use of the university's e-learning system (SIPDA), giving project assignments, and the form of project product targets that must be achieved in the OSH course are given. Project assignments are carried out through stages including: (1) Providing project examples and templates, (2) Assigning students to make project plans (project proposals), (3) doing their own projects, (4) reporting project results, and (5) sharing information on important findings of the project results. The project proposal assignments that have been uploaded by students are immediately checked by the instructor, and if they are appropriate, approval is given to continue implementing the project plan. The approved projects are carried out in business units that require OSH implementation, such as small and medium enterprises (SMEs), workshops, and home business units. Project reports are collected through SIPDA, and if students have difficulty uploading assignments, it can also be done through other forms online or offline. Project assignments are then assessed subjectively using an assessment rubric. Evaluation of learning outcomes is carried out in the middle of the semester (mid semester) and at the end of the semester (final exams) using multiple-choice objective tests that are systematically arranged covering OSH knowledge that has been learned during the implementation of learning. The potential of students to study OSH is also optimized through the provision of supporting materials that can be accessed by students online,

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both those provided in SIPDA and website links provided in the lecture materials, including examples of project implementation, videos of OSH cases, and articles that relevant to OSH. The e-learning facilities are also provided for discussion, mentoring, and assessment of learning outcomes. Students who have difficulties in learning are also facilitated with online discussions, either through SIPDA or through WhatsApp chat groups for courses. The achievement of student competence in the OSH field is measured by using learning outcomes that are assessed using an assessment rubric, and the evaluation of learning outcomes is assessed based on the scores achieved by students in the mid-semester and end-semester exams. Scores for project assignment products (proposals and reports) are obtained based on subjective assessments using an assessment rubric on a scale of 0-100. Scores for learning outcomes are obtained based on mastery of knowledge based on students' ability to answer questions correctly, and the score is converted to a value of 0-100. The results of the assessment are used as a determination of the achievement of student competencies in the OSH field.

Results

Learning resources for occupational safety and health courses

Teaching materials for Occupational Safety and Health courses have been arranged systematically starting from basic knowledge, advanced knowledge and the application of OSH. The OSH lecture materials consist of 13 main topics as summarized in Table 1. Each subject is developed into a complete teaching material for students to use in active learning, and packaged in such a way that the competency-based curriculum is presented in an interesting, informative, and adaptive manner of online and face-to-face teaching. Teaching materials are packaged into innovative learning resources through the integration of mini-projects and supplements that can help students learn to actively participate according to student needs. To make it easier for students to carry out their own projects, the learning resource package has integrated examples of correct task execution and assignment formats. The learning resource package that contains complete teaching materials, assignments, and project assignments, relevant multimedia, and well-packaged tools aims to train students to work independently or in groups in studying OSH. A package of learning resources for teaching Occupational Safety and Health is provided at SIPDA, and the descriptions of learning resources and their accessories are summarized in Table 1.

Standardization of project-based learning resource packages

The package of innovative learning resources based on the development project has been standardized using the eligibility criteria for learning resources set by the National Education Standards Agency (NESA or BSNP). Expert respondents who are professional lecturers, both internal lecturers and external lecturers voluntarily have given a good assessment of the learning resource package. The feasibility of learning resources for Occupational Safety and Health courses based on the results of respondents' assessments is summarized in Table 2. From the results of respondents' opinions, it is known that all parameter components contained in learning resources have met the requirements for use in teaching OSH in universities. Sequentially, the completeness and depth of the content of the teaching materials, the completeness of learning resources, the availability of project implementation instructions, the suitability of examples and references, the quality of the design and the appropriateness of the language, were stated to be very good by the respondents ($M=3.42\pm0.70$). Thus the learning resource package is ready to be used to support learning in OSH teaching.

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Table 1. Topics and brief descriptions of innovations in teaching materials for occupational safety and health courses for project-based learning.

No	Sub Topic (Material)	Brief description of integrated teaching materials and innovations	Supplements, tasks and projects
1	Concept of Occupational Safety and Health	Teaching materials on the concept of occupational safety and health are prepared in accordance with a competency-based curriculum with an KKNI orientation, equipped with learning media in the form of powerpoint presentation	Powerpoint presentation (PPT)
2	OSH Act	Teaching materials about the laws and regulations that apply in Indonesia that underlie OSH, equipped with learning media in the form of powerpoint presentation	PPT, website link for OSH Laws and Regulations files
3	OSH Management	Teaching materials on Occupational Safety and Health Management Systems, Corporate Hygiene, and the Committee for Occupational Safety and Health, are equipped with learning media in the form of powerpoints, and are equipped with assignments to analyze textbooks and review scientific journals	PPT, textbook analysis assignment template, e-book to be analyzed, scientific journal analysis assignment template, scientific journal access link
4	OSH Risk Management Hierarchy	Teaching materials containing the hierarchy of OSH risk control and personal protective equipment (PPE) are arranged systematically and completely, in depth, equipped with hyperlinks to electronic books and articles from reputable journals, multimedia, relevant videos adopted from Youtube, equipped with assignments given to students and project assignment formats	PPT, videos related to work accidents, project assignment assignment templates, project assignment report examples, OSH risk control journal examples
5	Fire Risk	Learning resources in the form of special topics are systematically made to provide reinforcement in the cause and prevention of fires, equipped with examples, journal hyperlinks, multimedia, and assignments	PPT, videos related to fire cases, case method assignment templates to analyze the causes and prevention of a fire case
6	Workshop Layout, Temperature Control, Lighting and Ventilation	Learning resources to learn the layout of the workshop, temperature regulation, lighting, and ventilation are arranged systematically, equipped with examples, materials for discussion, and powerpoint media	PPT, example of workshop layout and consideration of completeness of facilities
7	Environmental pollution	Teaching about environmental pollution, including air, soil, and water pollution, is packaged into interactive learning resources in the form of demonstrations through videos that can help students prevent environmental pollution. Learning materials are equipped with multimedia	PPT, videos related to environmental pollution, which are used as discussion material in class

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8	Hazardous Materials and Work Environment	Teaching materials about hazardous materials are well packaged, equipped with examples to make it easier to learn about hazardous waste and the work environment. Teaching materials are equipped with multimedia facilities	PPT and videos
9	Occupational Diseases and their Prevention	Learning resources contain teaching materials about diseases caused by work and how to prevent them, equipped with media in the form of powerpoints	PPT and videos
10	Machine Protection and Noise	Teaching materials on machine safety and noise, equipped with media in the form of powerpoints and assignments	Powerpoint, template for assigning causes of work accidents due to machines and designing machine safety
11	Environmental Impact and Threshold Limit Value	Environmental impact and threshold limit value teaching materials are well packaged, equipped with examples to make it easier to study environmental impact and threshold value. Teaching materials are equipped with multimedia facilities	Powerpoint, website link for regulations relating to threshold values in Indonesia
12	Ergonomics Concept	Teaching materials on ergonomics concepts are arranged systematically and completely, in depth, equipped with hyperlinks to electronic books and articles from reputable journals, multimedia, relevant videos adopted from Youtube	Powerpoint and the journal links related to ergonomics
13	Occupational Nutrition and Health Promotion	The teaching materials for Occupational Nutrition and Health Promotion are well packaged, equipped with examples to facilitate learning about occupational nutrition and health promotion. Teaching materials are equipped with multimedia facilities (posters and videos)	Powerpoint and the link sample posters and promotional videos

Table 2. Results of standardization of project-based innovative learning resource packages for occupational safety and health courses, based on the assessment of expert respondents following the nesa or bsnp criteria.

No	Description of the assessment of learning resource components	Respondent's Opinion	
		Internal (M±SDv, n=5)*	External (M±SDv, n=5)*
1	Completeness and depth of content of teaching materials: Complete teaching materials according to the IQF-oriented competency-based curriculum, content of teaching materials arranged systematically and completely, Occupational Safety and Health consists of 13 sub-subjects for undergraduate students, multimedia learning, hyperlinks to articles and cases of Safety and Health Occupational Health	3.40±0.52	3.40±0.70

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2	Completeness of learning resources: Integration of mini-project examples, assignment formats, worksheets, observation sheets, assignments, report templates, and result presentation formats	3.50±0.53	3.40±0.84
3	Availability of project implementation instructions, including; Project implementation guidelines, completeness of worksheets, observation sheets, data collection and processing tools, and project assessment rubrics (proposals and reports)	3.40±0.84	3.30±0.82
4	Design Quality: includes: compatibility of illustrations, pictures and tables with narration of learning resources and multimedia, illustration display, visualization quality, narrative text, and voice clarity	3.27±0.67	3.53±0.70
5	Language Eligibility: Readability of teaching materials and mini-project packages that are easy to read and understand, simplicity of presentation, good learning messages, and give the impression of long-lasting learning	3.47±0.52	3.47±0.84
Average		3.41±0.62	3.42±0.78

*Description: (4) Very Appropriate; (3) Appropriate; (2) Not Appropriate; and (1) Very Inappropriate.

Table 3. Themes of assignments and project assignments become the topic of occupational safety and health lectures.

No	Assignment Theme	Brief description of the assignment and project objectives
1	Assignment 1: Analysis of Fire Causes and Sources	Students can analyze and identify the factors that cause fires in Mechanical and Automotive Engineering work, know the steps taken to prevent and deal with fires, and know the impact of fires
2	Assignment 2: Machine Safety and Noise Analysis	Students can find out the factors that cause accidents caused by machines, design security on machines, and design work environments and machines to minimize noise
3	Assignment 3: Textbook Analysis	Students can analyze the contents of the textbook well, study, criticize, compare the contents of the main book and comparison books, and identify the parts of the book that are important and weak about OSH knowledge
4	Assignment 4: Scientific Journal Analysis	Students can analyze the contents of scientific journal articles, study, criticize the contents of several scientific articles from reputable journals, understand and compare the methods used to solve problems related to OSH
5	Assignment 5: Student Project Work	– Identifying potential hazards that occur in the workshop and SME business units – Analyzing the risks and impacts of work activities in SMEs – Determine appropriate risk control measures to solve OSH problems in SMEs to avoid accidents and work-related illnesses.

Students are very enthusiastic to use the learning resources that have been provided at SIPDA, and it can be seen from the amount of time provided by students studying online independently on their respective dashboards. The learning resource package is very effective in facilitating students' active learning, students can rely on the material provided in the learning resources for OSH knowledge enrichment, and has functioned effectively to help students do their

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own projects. The availability of examples that are integrated in learning resources has made it easier for students to complete the tasks given according to the topic being taught, including in project planning. The assessment of the assignments given in the lectures is summarized in Table 4.

Table 4. Student scores based on subjective assessments of project activities carried out by students in occupational safety and health lectures.

No	Project Assignment Assessment Component	Description of project assignment	Score* (M±Sdv, n=84)
1	Project task plan	Project assignment plans to be carried out after receiving input and review from lecturers	79.36±9.64
2	Project implementation report	Project implementation reports and findings, accuracy of the content with the task theme, content of reports and discussions relating the results of observations and analysis to previous research (relevant journals and books)	87.48±3.79
3	Presentation of project findings	Presentation on project implementation, project findings, ability to present, honesty, enthusiasm and fighting spirit	79.46±8.91
Average			82.10±8.72

*Obtained based on a portfolio of assignments and projects using a subjective assessment rubric

All assignments have been completed by students, useful in adding to OSH knowledge, and each task has been in accordance with the assignment objectives. Mastery of the targeted material in the OSH field has been achieved, which is shown by the students' mastery in completing assignments and answering the evaluation of learning outcomes correctly. Student achievement based on the average project assignment portfolio score is good (M=82.10±8.72). These results ensure that the innovative project-based learning resources available at SIPDA have helped students learn and can be developed for the achievement of student competencies. The results of the implementation of innovative learning resources for OSH teaching prove that the available innovative learning resources have been proven to be effective in facilitating active learning activities, strengthening teaching, making lecture materials easy to understand and assignments can be done correctly.

Implementation of project learning for the teaching of Occupational Safety and Health was chosen as a strategy in directing students to master OSH knowledge and skills. Assignments and projects have maximized students' active learning to increase their knowledge on OSH, which is shown by mastering the OSH material and as an implementation of competency achievement. Student learning outcomes based on subjective assessments and objective assessments are summarized in Table 5. The average student achievement is (M=88.56±7.14), which is a combined assessment of the subjective value of attendance in lectures, subjective scores of coursework including projects, grades the objective of the midterm exam (Mid test), and the objective value of the end of the final semester exam (Final test). The achievement of student learning outcomes is classified as very good, students have studied thoroughly, skills and knowledge in the field of OSH have been developed, and competence in the field of OSH has been achieved.

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Table 5. Student learning outcomes based on the cumulative of subjective assessments and objective assessments of occupational safety and health courses

No	Assessment of Learning Outcomes	Score* (M±Sdv, n=84)	Decision
1	Attendance in blended lectures	93.82±7.52	Complete study
2	Assignments integrated with course teaching in one semester, and project reports	81.73±4.56	OSH skill achieved
3	Midterm exam (Mid test)	88.38±8.85	OSH knowledge achieved
4	Final semester exam (Final test)	90.32±7.61	OSH knowledge achieved
Average		88.56±7.14	OSH competence achieved

*Obtained based on subjective assessment and objective assessment into conversion score results

Discussion

The availability of complete and innovative learning resources in Occupational Safety and Health lectures is the key to success in the implementation of active learning, because learning resources have dual functions, namely as a source of knowledge and also as a guide in improving skills and knowledge in order to achieve the desired competencies in accordance with the curriculum targets. The implementation of active learning through project-based learning is very relevant for teaching Occupational Safety and Health courses because it requires adequate knowledge and practice of safety in the workplace [20,21]. Innovative learning resources can be used to guide students in active learning through the implementation of academic activities such as assignments, case studies, projects, and inquiries that can bring students closer to theory and practice in OSH teaching [22-25]. The results of this study have proven that innovative project-based learning resources have effectively guided students to complete assignments well, and students can design and implement projects related to Occupational Safety and Health. The project-based learning model has brought students to be actively and directly involved in learning as well as practicing OSH, namely as a strategy to increase the knowledge and skills needed in completing their lectures [26,27].

Occupational Safety and Health is very much needed by students of the Automotive Engineering Education Study Program, because it becomes their daily life in dealing with the potential risk of accidents at work. Knowledge of safety theory and project examples provided in the learning resources make it easier for students to carry out assigned projects. Multimedia integration has been designed for online and offline learning to facilitate students' independent learning to be able to plan and implement projects contextually. Through project implementation, students are directly involved, motivated to carry out tasks to produce products in order to achieve their competencies [28]. Innovative project-based learning resources have increased skills and knowledge in the field of Occupational Safety and Health. Project-based learning through the provision of innovative learning resources is very appropriate for the teaching of Occupational Safety and Health. It is recommended that the project-based learning model be implemented in other teaching courses in the Automotive Engineering Education Study Program because it motivates students to learn actively, independently, and effectively in achieving the competencies needed as life skills after completing their studies.

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Conclusion

Project-based learning is very appropriate to be implemented in Occupational Safety and Health courses, because students are directly involved in gaining experience in safety and work safety and avoiding accidents. The learning resource package consists of 13 topics equipped with mini projects, multimedia, and learning support tools that are compatible for blended learning. Innovative learning resources as a result of development have proven to be effective for students to learn actively, guide students to do assignments and do projects correctly, and efficient templates to guide students to report and present their findings about job safety in various jobs in workshops and small and medium business units. The availability of innovative learning resources in this learning model will make learning take place systematically and holistically as a strategy for achieving competence. Students have studied Occupational Safety and Health thoroughly, which is shown from the results of the subjective assessment for assignments and project reports (M=81.73±4.56) very well, and from the results of the objective assessment of OSH knowledge in the midterm exams (M=88.38±8.85) and end of semester exams (M=90.32±7.61) all were very good. These results ensure that competence in the field of OSH has been achieved. Project-based learning using innovative learning resources is appropriate for the Automotive Engineering Education Study Program because it motivates students to learn actively to achieve the competency targets set in the curriculum.

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Profile of Technology Pedagogical Content Knowledge-21 (TPACK-21) on pre-service science teacher in microteaching course

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Abstract. *The purpose of this study was to obtain an overview of the TPACK-21 profile of prospective science teacher students after attending microteaching lectures using hybrid learning. The research design used in this study is a survey research design. Research Subjects The subjects of this study were all students of the Science Education Study Program, Faculty of Mathematics and Natural Sciences, State University of Medan who took part in Microteaching lectures in the even semester of 2021-2022 consisting of 60 students. The profile of the TPACK-21 science teacher candidate for the Science Education study program at the State University of Medan shows that the seven aspects of TPACK-21 show six aspects in the sufficient category, namely: (1) Pedagogical Knowledge (PK); (2) Technological Knowledge (TK); (3) Content Knowledge (CK); (4) Pedagogical Content Knowledge (PCK); (5) Technological Content Knowledge (TCK); and (6) Technological Pedagogical Content Knowledge (TPACK-21). One aspect of the category lacking is Technological Pedagogical Knowledge (TPK).*

Keywords: TPACK profile, pre-service science teacher

Introduction

Teaching and learning activities have shifted from traditional to ICT-based learning [1]. One of the learning frameworks that incorporates technology into learning is the TPACK (Technology, Pedagogical Content Knowledge [2,3]. This strategy necessitates instructors' ability to include the use of technology to create a learning environment while also paying attention to the pedagogical factors inherent in learning content while teaching the topic to students [4,5].

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Medan Negeri Medan is one of the LPTK (Institutions for Education for Education Personnel) that provides teacher knowledge and the challenge of giving the abilities to create and manage learning in the classroom via the use of diverse technology resources. Students and instructors must master a range of technological skills in order for learning to become efficient and successful in reaching learning objectives [6]. Designing lectures that can contribute to the development of TPACK for prospective teachers is one strategy that might be explored. Without the availability of the capacity to integrate ICT in the education process of prospective teachers, the teacher's competence would be left behind and unable to respond to the difficulties of technological advancements in the current period [7,8].

According to the 2020 Regional Education Balance (NPD) statistics, the average pedagogic value of teachers in North Sumatra province is 48.04, with a teacher professional score of 54.31 and a total average score of 52.43 [9]. Even though the Ministry of Education and Culture targets in 2020 the average value of teacher competence is 80. Based on these facts, it can be said that the competence of teachers in North Sumatra is still relatively low. Some of the factors causing the low value of teacher competence include lack of computer mastery, lack of material mastery, lack of preparation/socialization, lack of exam time, and unclear question editors [10,11]. One of the causes for instructors' incapacity to teach is a lack of mastery of the abilities held by these teachers [12,13]. On the ground, schools and teachers in Indonesia continue to face issues such as teacher standards, mastery of content, and a lack of media and technology/literacy media and technology [14,15]. There is no change in the quality of Indonesian education before and after teacher certification is established. Despite spending a lot of money, the World Bank claims that teacher certification has little effect on educational achievements [16,17].

To address these issues, teacher professional education programs continue to seek effective techniques for preparing professional teachers to integrate technology in their classrooms [18]. The teacher professional preparation program must develop a multidimensional approach that focuses on developing teachers in teaching specific subject areas with technology [19,20], for which the profile and abilities of 21st century TPACK teacher candidates for Natural Sciences education programs Universitas Negeri Medan.

The Science Education study program is responsible for graduating prospective science teachers at the Junior High School (SMP) level who are capable of meeting the challenges of incorporating ICT into the learning process. Students in junior high school are postmillennial youngsters who are already quite familiar with different electronic gadgets and the internet; incorporating ICT into learning in junior high schools has significant potential to increase the quality of learning in junior high schools [21]. One thing researchers may do is create lecture programs that will prepare potential instructors to incorporate technology into learning. One learning strategy that can be employed is the TPACK framework, which focuses on the integration of technology, pedagogy, and content in learning. This strategy necessitates instructors' ability to include the use of technology to create a learning environment while also paying attention to the pedagogical factors inherent in learning content while teaching the topic to students [22,23]. To do this, it is necessary to first create a thorough and comprehensive profile of potential teacher students' TPACK abilities in microteaching lectures. This research will result in a TPACK-based microteaching learning innovation that will be coupled to attain 21st century competency for junior high school prospective science teacher students. In this study, the issue formulation is what is the profile of TPACK for potential science instructors after attending microteaching courses.

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Methodology

The research design for this study is a survey research design. A survey research design is a quantitative research technique that uses a sample of the population to offer a description of the attitudes, habits, and characteristics of the population [24]. The TPACK profile of Science Education Study Program students after attending the Microteaching Lecture employing hybrid learning will be assessed in this study.

A self-assessment questionnaire was used in this study to investigate the components of TPACK-21, which included Pedagogical Knowledge (PK), Technological Knowledge (TK), Content Knowledge (CK), Pedagogical Content Knowledge (PCK), Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK), and Technological Pedagogical Content Knowledge (TPACK) [25]. The seven variables are then described into 35 instrument items as shown in Table 1.

Table 1. Variable indicators of research

Variabel	Item Kode	Item
Pedagogical Knowledge (PK)	PK1	Variations of approaches, models, strategies, methods, media, science learning techniques
	PK2	Instructional techniques for honing critical thinking abilities
	PK3	Learning techniques for honing creative abilities
	PK4	Learning strategies that can practice communication skills
	PK5	Learning techniques for guiding students
Technological Knowledge (TK)	TK1	Learn about the evolution of new technology and its characteristics.
	TK2	Using technology in developing learning tools
	TK3	Using technology tools in learning
	TK4	Using applications developed by the Ministry of Education and Culture
	TK5	Application development for assessment instruments and value processing
Content Knowledge (CK)	CK1	comprehension of the curriculum 2013 as well as the Kurikulum Merdeka
	CK2	understanding of basic science theory and
	CK3	Mastery of knowledge to develop science content
	CK4	Understanding of the history and development of major scientific hypotheses
	CK5	Knowledge of the most recent scientific research

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Pedagogical Content Knowledge (PCK)	PCK 1	Knowing and studying material that is in accordance with approaches, models, strategies, methods, media, science learning techniques
	PCK2	Knowing science learning strategies that can help kids practice critical thinking capabilities
	PCK3	Knowing science learning strategies that can aid kids in performing creative skills
	PCK4	Knowing science learning strategies that can aid pupils in exercising communication skills
	PCK5	Knowing science learning practices that can help pupils solve group challenges
Technological Pedagogical Knowledge (TPK)	TPK1	Utilizing ICT as a learning medium to enable students to learn on their own
	TPK2	Using ICT as a medium for students' critical thinking in the classroom
	TPK3	Utilizing ICT in education as a tool for students' creative thinking
	TPK4	Utilizing Technology in the classroom to facilitate students' reflective thinking
	TPK5	Using ICT in education as a medium to solve student problems in groups
Technological Content Knowledge (TCK)	TCK1	Using ICT in education as a tool to solve student issues in groups
	TCK2	Be careful of websites that provide online resources for learning science subjects.
	TCK3	Understanding ICT applications that may be utilized to better grasp science learning material and eliminate misunderstandings
	TCK4	Understand the technologies that can be utilized to assist convey difficult science
	TCK5	Understanding the technologies that may be utilized to create assessment tools for scientific learning
Technological Pedagogical Content Knowledge (TPACK)	TPACK1	Knowing how to utilize ICT as a tool to assist students communicate ideas with one another in science study.
	TPACK2	Knowing how to utilize ICT as a tool to assist students exercise critical thinking abilities in scientific teaching.

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	TPACK3	Understanding how to use ICT in science education as a tool to help students practice creative thinking skills.
	TPACK4	Understanding how to utilize ICT in scientific education as a tool to help students exercise reflective thinking abilities.
	TPACK5	Knowing how to utilize ICT as a tool to assist group problem solving activities for students in scientific learning

This study's validation is based on a grid derived from relevant literature and expert opinion. The findings of this validation are used to improve the research instrument. The prepared research instrument will be presented to validator specialists who are familiar with the TPACK-21 instrument. A Likert scale was then used to score the questionnaire. The variables to be measured are described as variable indicators using the Likert scale. There are 5 (five) possible answer choices on the Likert scale. Strongly Agree (SS) = 5, Agree (S) = 4, Disagree (KS) = 3, Disagree (TS) = 2, and Strongly Disagree (STS) = 1 are the five scales.

Results and discussions

The TPACK-21 instrument in the form of question items is made in the form of a google form. The TPACK-21 instrument was distributed to 60 respondents from the Science education study program at the State University of Medan who took microteaching courses in the even semester of 2021-2022. The data from the filling in is then analyzed to see the profile of prospective science teachers in each component of TPACK-21.

The results of the data analysis of the TPACK-21 questionnaire for prospective science teacher students in the Science Education Study Program at the State University of Medan, the recapitulation is presented in Table 2.

Table 2. Results of the questionnaire analysis of each aspect of TPACK-21.

Aspek TPACK-21	M	SD	Criteria
Pedagogical Knowledge (PK)	3.12	0.10	Enough
Technological Knowledge (TK)	2.74	0.78	Enough
Content Knowledge (CK)	3.14	0.04	Enough
Pedagogical Content Knowledge (PCK)	3.02	0.11	Enough
Technological Pedagogical Knowledge (TPK)	2.48	0.08	Deficient
Technological Content Knowledge (TCK)	3,01	0,07	Enough
Technological Pedagogical Content Knowledge (TPACK)	2,89	0,08	Enough

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The data presented in Table 1 recapitulation of the results of the questionnaire analysis of each aspect of TPACK-21 shows that the seven aspects of TPACK-21 science teacher candidates for the Science Education study program at the State University of Medan show 6 aspects in the sufficient category, this indicates that the skills of prospective science teachers in preparing learning tools based on TPACK in microteaching courses still needs a significant increase, from 6 aspects with sufficient categories, Pedagogical Knowledge (PK) and Content Knowledge (CK) aspects with the highest scores indicate that students' understanding of science material content, especially at the secondary school education unit level. The first is better than other aspects, but the findings of this study indicate that the understanding of prospective science teachers for science education study programs is not good because it is still in the sufficient category, Content Knowledge refers to knowledge of subject matter that must be mastered when teaching, for that it is necessary for prospective teachers to master it well [26,27]. Pedagogical Knowledge in the context of this research is seen by the ability of students to understand about approaches, models, strategies, learning methods that can be applied in science learning. However, the findings of this study indicate that the mastery of prospective teachers is also still in the sufficient category, so that further improvements are needed so that mastery of Pedagogical Knowledge can be better, understanding of Pedagogical Knowledge related to learning design, where if not optimal learning planning will lead to an ineffective learning process and efficient [28]. Before developing a lesson plan, prospective teachers must understand learning theory, because learning theory emphasizes how one should learn [29,30].

Prospective science teachers already know about technology that can be used to help describe difficult content in science and develop assessment instruments in science learning, which still needs to be improved in terms of finding websites that contain online materials for studying science content, enhanced knowledge of ICT applications commonly used in science learning to help When not demonstrated, mastering Technological Content Knowledge (TCK) is proven to be able to help teachers understand how to plan and implement learning by integrating technology in the classroom [31]. Because technology-integrated content knowledge and pedagogical skills are important conditions in creating effective classroom teaching and innovative use of technology, mastering TCK is proven to be able to help teachers understand how to plan and implement learning by integrating technology in the classroom [32].

In this study, the category sufficed for Pedagogical Content Knowledge (PCK). Prospective science teachers have studied material in accordance with approaches, models, strategies, methods, media, and techniques in developing science learning tools, which have not been maximized in designing activities in science learning that can guide students in practicing critical thinking skills, communication skills, and group problem solving; they are still lacking in designing activities in science learning that can guide students in practicing creative skills. PCK is a teacher's understanding of how to create learning settings that assist pupils grasp the content of scientific truths. PCK is essential information that prospective instructors must grasp in order to assist and support pupils in understanding difficult ideas [33]. PCK can also improve knowledge and skills including the ability to think critically, creatively, communicate and collaborate [34].

Aspects of Technological Knowledge (TK) in this study obtained a sufficient category. Prospective science teachers already use computers in developing science learning tools, use computers/LCD/Video in media learning, science teaching materials and integrate applications to develop assessment instruments and value processing in developing science learning tools such as quizizz, kahot and google forms found in the design structured learning. What needs to be

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improved by prospective teachers is that before integrating technology in learning, they need to analyze the material [35,36].

Aspects of Technological Pedagogical Knowledge that fall under the less category (TPK). This finding indicates that prospective science teachers still have difficulty integrating technology into the learning process. Although prospective teachers' mastery of technology is good due to the support of the times, prospective teachers have difficulty integrating technology into the learning process. Concerning the completeness of technical equipment for practicing instruction in PLL activities, not many schools have technological facilities such as LCD/projectors that can assist them in teaching [37,38]. The integration of technology in learning practices necessitates the participation of instructors in order for the presence of technology in learning practices to continue in order for learning to be more effective, efficient, and enjoyable, as well as to increase performance [39,40].

Conclusion

According to the profile of the TPACK-21 science teacher candidate for the Science Education study program at the State University of Medan, six of the seven aspects of TPACK-21 are sufficient, namely: (1) Pedagogical Knowledge (PK); (2) Technological Knowledge (TK); (3) Content Knowledge (CK); (4) Pedagogical Content Knowledge (PCK); (5) Technological Content Knowledge (TCK); and (6) Technological Pedagogical Content Knowledge (TPACK). Technological Pedagogical Knowledge is one part of the category that is inadequate (TPK).

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The development of university cooperation governance tools to support the achievement of key performance indicators

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Abstract. *The policy of the Ministry of Education, Culture, Research and Technology of the Republic of Indonesia (Kemendikbudristek RI) to improve the quality of higher education, carried out through the achievement of key performance indicators (KPI) needs support. The provision of university collaborative governance tools is needed to facilitate the achievement of the KPI, which can be used as a guide for implementing university activities with cooperation partners. This study aims to develop collaborative governance tools to facilitate the achievement of the University's key performance indicators. The research is conducted through meeting the need for collaborative governance tools, standardizing, and implementing them in academic and non-academic university activities. The results of the study indicate that standard cooperative governance tools and supporting tools have been arranged. The cooperative governance tool received very good reviews from respondents and was appreciated by partners as the basis for implementing university activities. Student activities are facilitated through collaboration, including credit exchange, internships, village projects, teaching, research, and entrepreneurship. Through cooperative ties, the activities of lecturers outside the campus and industry are protected, and the presence of teaching practitioners at the university is facilitated. Documents resulting from the development are ready to be used as policies, regulations and guidelines for university cooperation.*

Keywords: cooperation governance; university performance; academic activities; student activities; cooperation partners

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Introduction

One strategy to improve the quality of higher education in Indonesia is through the establishment of eight key performance indicators (KPI). This policy was set by the Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia (Kemendikbudristek RI), as a top priority that needs to be achieved by universities. This performance indicator is a breakthrough in accelerating the achievement of goals, targets, and plans that have been determined by the University. The achievement of KPI must be supported and facilitated through university policies [1,2]. In brief, the eight main performance indicators are: (1) Students get a job, are self-employed, or continue their studies, (2) Students gain work experience outside of campus, (3) Lecturers have activities outside campus such as in industry or on other campuses, (4) The University involves teaching practitioners on campus, (5) Lecturers' innovative products are utilized by the community or get international recognition, (6) Study programs in collaboration with world-class partners, (7) Have collaborative and participatory classes: Group project-based evaluation or case studies, (8) Study programs reach international standards [3].

Management tools in the field of cooperation are needed to regulate the implementation of cooperation activities in the academic and non-academic fields, and become a reference to ensure the implementation of the agreed cooperation program [4,5]. The implementation of cooperation in higher education is a driving force in increasing progress, and accelerating the success of institutions [6,7]. Through collaborative activities, a desire to help each other will be achieved which can be beneficial for both parties, and will ultimately affect the health of the organization. The implementation of a good cooperation program is the key to creating the filling of needs in the two partnering parties, and at the same time promoting the advantages of each institution to complement each other for the achievement of goals [8]. Through collaborative activities, the efficiency, security and health of the organization will be created [9]. Good cooperation governance guarantees the implementation of quality cooperation activities, affects service quality, and will improve institutional integrity [10]. The purpose of this research is to develop and implement governance tools in the field of cooperation in facilitating the achievement of university performance indicators, in achieving university excellence internally, externally and internationally.

Methodology

Location and object of research

The research is the development and implementation of collaborative governance tools intended to facilitate the achievement of KPIs carried out at universities with cooperation partners in districts and cities in North Sumatra. The object of the research is the governance document in the field of cooperation that supports the achievement of university performance indicators in accordance with the research objectives.

Population and research sample

In accordance with the purpose of this study, the research population is the functionaries of Departments and Study Programs at the University, and cooperation partners. The research sample is the total sample who is willing to participate in research such as university functionaries and cooperation partners who are directly involved in academic activities relevant to the university's KPI.

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Research procedure

The study was carried out following the procedure described in previous studies with modifications to obtain a cooperative governance tool related to the achievement of KPI [1,2,4,11,12]. The stages of the research include drafting documents for governance tools in the field of cooperation and their supporting instruments, validation and standardization of instruments using university functionaries respondents and external cooperation partners, aligning documents in the field of cooperation with university regulations, and implementing governance instruments for the achievement of KPI [13,14]. Alignment of documents with university policies is carried out by focusing on activities related to achieving KPIs that do not conflict with current regulations. The governance document in the field of cooperation is submitted to the University Senate to be considered as a University regulation in the form of a Rector's Decree.

Results and discussions

Document of university cooperation governance tool

The preparation of governance tools documents is the main target of this research, which is intended to facilitate the achievement of the university's main performance indicators. Some of the emphasis is focused on collaborative activities that regulate the academic activities of students and lecturers to facilitate the smooth implementation of the Merdeka Learning Campus (MBKM) activities. Management tools are arranged according to the potential of the university, to meet the needs of the Study Program at the Faculty, and also adjust to the availability of resources at the university. The needs analysis is carried out based on an analysis of the availability of documents related to cooperation that applies at the university and is still needed by the academic community at the university. To complete the governance tools, input is collected from units that are stakeholders of the university such as Study Programs and cooperation partners. Opinion gathering from functionaries and cooperation partners is very important to get a cooperative management tool that is in accordance with the needs of the university. The components of the governance tool for the field of cooperation are designed to become a policy document that regulates cooperation in facilitating the achievement of the university's main performance indicators. The assessment and alignment of document components is then carried out by stakeholders until all needs related to the cooperation of the Study Program and other units at the university can be accommodated. The main performance indicators of universities facilitated through collaborative activities are summarized in Table 1.

Cooperation policy related to student activities

Several articles in the cooperation document have been designed to regulate collaborative activities that can facilitate the success of the University's main performance indicators related to student activities. The articles in the document are needed to regulate student academic activities such as further studies, industrial and business internships, implementation of village projects, teaching in schools, conducting research, entrepreneurship, and student exchanges between universities as summarized in Table 2. Respondents gave an assessment very good (M=3.52±0.66) towards the articles in the documents related to student academic activities. All articles (nine articles) provided in the document were approved by the respondents because they are considered relevant to student activities in increasing the knowledge and skills needed after completing their studies, in addition to the core competencies obtained in the study program.

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Table 1. Potential achievement of key university performance indicators that can be facilitated by the availability of governance tools in the field of cooperation

No	Key University Performance Indicators#	Achievement of KPI*		
		Baseline	Potential	Realization
1	University graduates get decent jobs and further studies	√	√	√
2	Students get an off-campus learning experience	√	√	√
3	Lecturers have off-campus activities		√	√
4	Practitioners and experts are invited to teach on campus		√	√
5	The product of the lecturer's work is used by the community	√	√	√
6	Study Program in collaboration with world-class partners	√	√	√
7	Collaborative and participatory classes	√	√	√
8	Study Programs have international standards	-	√	-

Identified at the time of research

Table 2. Articles in the cooperative governance tool document that regulate student activities and the results of respondents' assessments

No	The articles in the document become policy	No of articles	Respondents' assessment results* *n*=21, (*M*±*Sdv*)
1	Study outside the Study Program	1	3.50±0.74
2	Certified Internship in Industry and Business	2	3.45±0.67
3	Village project implementation	1	3.73±0.55
4	Teaching in schools	1	3.55±0.60
5	Doing research in formal institutions	1	3.50±0.74
6	Entrepreneur	1	3.36±0.73
7	Student Exchange at Home and Abroad	2	3.55±0.60
Total/Average		9	**3.52±0.66**

*Likert scale with 4 choices: (4) Very Appropriate; (3) Appropriate; (2) Not Appropriate; and (1) Very Inappropriate

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Cooperation policy related to lecturer activities

The excellence of lecturers as a resource is the key in improving the quality of students and graduates. Quality lecturers will affect the quality of their learning, especially producing innovative learning according to contemporary needs. For this purpose, it is necessary to have an article in the cooperative governance tool document that regulates the activities of Lecturers, both as internal lecturers and as external lecturers. The articles provided in the documents related to the activities of the lecturers and the results of the respondents' assessments are summarized in Table 3. Respondents gave a very good assessment (M=3.46±0.71) to all articles in the cooperative governance toolkit documents related to the activities of Lecturers. Of the six articles of the cooperative governance toolkit that regulates the activities of lecturers, all of them were approved by the respondents as university regulations. The articles of governance in the field of cooperation provided in the document have been able to facilitate internal lecturers in activities outside the campus as well as in the promotion of their expertise. These articles are also sufficient in regulating the activities of external lecturers in university activities to demonstrate the skills needed by students. The university's excellence is also illustrated by the university's success in achieving KPI targets related to Lecturer activities, because it facilitates lecturers to implement theory and practice contextually in their services in the community.

Table 3. Articles in the cooperative governance instrument document that regulate the activities of lecturers and the results of the respondents' assessments

No	The articles in the document become policy	No of articles	Respondents' assessment results* *n*=21, (*M*±*Sdv*)
1	Activities of internal lecturers outside campus	1	3.50±0.74
2	Activities of internal lecturers in industry and the business world	1	3.45±0.74
3	Activities of external lecturers (practitioners and experts) on campus	2	3.36±0.73
4	Promoting university lecturers based on their expertise, research results, innovative findings, and services used by the local community	2	3.32±0.72
	Jumlah/Rerata	6	3.46±0.71

*Likert scale with 4 options: (4) Very Appropriate; (3) Appropriate; (2) Not Appropriate; and (1) Very Inappropriate

Cooperation policy related to internationalization

The university's expansion in academic and non-academic activities globally is the university's lofty goal. The university will be proud if it can promote its excellence internationally. For these activities, partners both at home and abroad are needed. University partners can be used by students and lecturers in implementing university excellence, as well as a comparative study in getting new things from international partners that are suitable to be applied at universities. The set of governance arrangements for cooperation related to academic and non-academic activities on an

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international scale has been compiled consisting of five articles. These articles are believed to be able to facilitate Study Programs, Departments, Faculties by involving lecturers and students in carrying out international activities as summarized in Table 4. The results show that respondents strongly agree (M=3.44±0.75) with the articles presented in the cooperative governance tool. relating to international affairs into a policy of cooperation. The cooperation management tool is intended to regulate university collaboration with world-class partners such as curriculum development, international internships, and absorption of graduates. Through collaboration with international partners, it will be possible to adjust courses in the Study Program to meet the needs of employment at the international level.

Table 4. Articles in the cooperation governance instrument document governing international cooperation and the results of respondents' assessments

No	The articles in the document become policy	No of articles	Respondents' assessment results* *n*=21, (*M*±*Sdv*)
1	Collaborative activities with world-class partners related to curriculum development activities, internships, and absorption of graduates	2	3.41±0.80
2	Academic activities in Study Programs in collaboration with world-class partners	1	3.59±0.67
3	University cooperation activities with world-class partners related to scientific development	2	3.32±0.78
	Total/Average	5	3.44±0.75

*Likert scale with 4 options: (4) Very Appropriate; (3) Appropriate; (2) Not Appropriate; and (1) Very Inappropriate

DISCUSSION

The main targets of achieving the university's Key Performance Indicators have been detailed in the guidebook provided by the Ministry of Education and Culture of the Republic of Indonesia. As an implementation of the guidelines, the university provides documents for collaborative governance tools related to academic and non-academic activities to facilitate the achievement of KPI. This cooperative governance tool binds the academic community to carry out activities on campus and outside campus. The availability of cooperative governance tools is used to facilitate, regulate and guide various academic and non-academic activities carried out by students and lecturers [15,16]. Achievement targets include graduates getting decent jobs, creating jobs, and continuing their studies as a result of implementing quality learning [17,18]. The success of alumni is an indicator of the quality of the university, starting from the provision of curriculum and the availability of resources needed by the world of work and community needs. The variety of academic and non-academic experiences outside the campus are activities that can build student skills through internships, research and other activities according to the study program. these activities become a strategy in developing students' self with partners outside the campus [19].

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Academic and non-academic activities carried out by lecturers outside the campus are a means to spread the expertise of lecturers, and provide added value to the university. The lecturer's activities will be optimal if they are facilitated through formal collaborative activities. The arrangement of internal Lecturer activities outside the campus and in carrying out experience in the industry is very important for the lecturers themselves and for the Study Program because this program will directly bring the latest developments and advances into the campus, and if implemented will be able to complete the competencies required by students in the world of work. according to the study program [20,21]. Lecturer activities in the external environment need to be facilitated by the availability of documents for collaborative governance and supporting instruments. With the same pattern, external lecturer activities are also arranged to work in the campus environment. Through collaboration, the activities of external lecturers, namely experts and practitioners who are experienced in the industry have the opportunity to teach at the University, so that field experience and skills can be immediately possessed by students in preparing themselves to anticipate job opportunities. Policy documents compiled in the cooperative governance apparatus as a guarantee and certainty for lecturers in promoting the potential of lecturers in the form of expertise, research results and lecturer services that have been used by the community or received international recognition. Industrial cooperation with universities is very important, especially to facilitate students in the Independent Learning and Independent Campus (MBKM) program. Cooperation will provide benefits to both parties, universities and cooperation partners, especially to the wider community [22,23]. By using this governance tool, the KPI related to lecturer activities will be achieved with very good results. Involving experts and practitioners to implement their experiences on campus is a means to bring campus closer to the real world in industry and society. Practitioners will pass on their knowledge and experience to students to equip students with the skills needed by the world of work, which can be done through collaboration [24-25].

Utilization of products and works of lecturers in the community is an indicator of university excellence. The cooperation that is built between universities and partners will provide a guarantee to bring the campus closer to cooperation partners. The pursuit of world-class study programs is the university's advantage, which can be facilitated through collaboration with world-class partners. Selection and facilitation of collaboration with partners can be carried out for mutual discussion in various matters, for example to improve Study Programs, implementation of research collaborations, sharing scientific activities, and international internships in foreign agencies. Facilitating the achievement of the number of collaborative and participatory classes is the target in optimizing student involvement in teaching and learning activities that are good in achieving their competencies [26-28]. Governance in the field of university collaboration facilitates Study Programs to have partners at international standard universities which has an impact on motivating study programs to achieve international accreditation.

Conclusion

Fulfillment of key performance indicators as a description of the achievement of goals, objectives, and development plans that have been determined in the strategic plan of the University. The results of the research have compiled a standard cooperative governance tool, and implemented it to regulate academic and non-academic activities by campus residents and cooperation partners. Various rules have been contained in the cooperation governance document to regulate

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cooperation policies related to student activities, cooperation policies related to lecturer activities, and cooperation policies related to international relations. The implementation of cooperative governance has served as a guide for Faculties, Departments, and Study Programs to carry out academic and non-academic activities at local, national and global levels. The availability of cooperative governance tools will be able to facilitate universities to achieve optimum university performance based on the superiority of available resources at the university. This governance tool for the field of cooperation will become an official university document that will be submitted through the University Senate to become the Chancellor's decree

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Professional development in enhancing teachers' digital competence: a systematic literature review

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Abstract. *Since digital competence is increasingly needed in learning, developing the competencies becomes crucial for teachers' performance. However, many programs were found less effective and insufficient. It is needed to figure out the best concrete ways to enhance teachers' digital competence. This paper aims to provide a current overview of relevant learning strategies and appropriate tools in digital competence training or professional development for in-service teachers. This systematic review used Science Direct, ERIC, and Taylor & Francis as databases to store and analyze the existing research. The data was searched based on PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) Statement Guidelines. We delimited the search to title, abstract, and keywords in the databases, published after being submitted to a peer review process, and written in English from 2019 to 2022. Eventually 13 articles were selected. Among the conclusions, we highlight that the most presented type of TPD was accompanied by mentoring and carried out for a certain period. The participants were given a briefing at the initial meeting, followed by making products or preparing lesson plans to be further integrated into teaching, then continued by looking at learning outcomes or seeing student responses.*

Keywords: digital competence, teacher professional development, training, review, digital literacy

Introduction

The development of digital competence is found crucial for teachers' performance [1]. It is developed during initial teacher education and continued during teaching career [2,3]. Professional development for in-service teachers is essential as a cornerstone in achieving the goals of educational reforms [4-6]. Teachers should be trained or developed through training or professional development (PD) in technical skills and pedagogical competencies [5-8]. A high level of knowledge and use of digital technologies in the classroom is not enough if teachers do not know how to apply technology, because technology itself does not improve teaching and learning [9,10]. For example, teachers who tried to encourage synchronous collaboration and learner engagement through multimedia, discussions, and scaffolding techniques, found that students visibly lacked engagement [4,6,11].

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'Digital competence' (DC) has become a key component in curriculum development, educational policy, and research during the last decade [12]. The general description of digital competencies comprises into five areas: information and data literacy; communication and collaboration; digital content creation; safety; and problem-solving [13]. Taken from Professional Digital Competence Framework for Teachers [2], there are 7 components in the framework, which are: 1) subject and basic skill: skill to acquire and consider, produce and process, communicate, digital judgment; 2) school and society: understands teacher own role, and the role of schools, in bridging the digital divide, and is able to help all children and young people orient themselves and be active participants and contributors in a global, digital and democratic society, also in tomorrow labour market; 3) ethics: insight into the legislation and ethical concerns and contributes to developing pupils' digital judgement, understanding and ability to act in line with these, 4) pedagogy and subject didactics: integrates digital resources into their planning, organization, implementation and evaluation of the teaching in order to foster pupils' learning and development; 5) leadership of learning process: understand and able to develops a constructive and inclusive learning environment, facilitates both diverse groups of pupils and pupils' individual needs, and uses diverse forms of assessment to foster their desire to learn, learning strategies, and learning competence, 6) interaction and communication: use digital communication channels for information, collaboration, and knowledge sharing with various stakeholders in a way that builds trust, and contributes to participation and interaction; 7) change and development: improves their competence and adapts their own practices, based on research and development by driving their own development work and contributing to a shared culture around learning, in a digital environment. What can be seen is that while the teacher prepares and develop himself, the teacher also demands to develop students' digital competence.

Erstad [14] pointed out a lack of research in digital competence. In addition, Elliot (2017) also argues that many PD programs is not sufficient and not effective. It is needed to figure out the best ways to teach DC for educational practitioners. A concrete suggestion is needed to organize structured in-service training to increase teacher educators' motivation [16]. These studies altogether indicating more research on DC, including developing an effective instructional design for future teachers' professional development (TPD) or training is needed.

Up to now, there is a lack of review on how training or professional development enhances teachers' digital competence. Since pre-service teachers reported having better competence in developing digital technology in the school curriculum [19], this research is limited to in-service teachers. In 2015, Khalid [17] conducted systematic review research. The data were searched from EBSCO before 2014. The article presented the definition of Digital Literacy or Competence (DL). It also reported the development of DL for all level teachers (i.e., student, pre-service, in-service) with the model of development. Since then, no research has been found similar to this topic. Although there was research using primary data from 2008 to 2018, aligned to the topic above, the discussion is limited to research trends and the impact of TPD in enhancing teacher digital competence [18].

Considering all inadequate evidence, organized and synthesized studies are needed to inform policymakers, designers, educators, teachers, or practitioners how TPD should be conducted to improve in-service teachers' digital competence. Therefore, this study is to review TPD in improving in-service teachers' digital competencies.

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Methodology

The study was guided by the principles of the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement. PRISMA can be used as the foundation for reporting a systematic review [20]. This method was introduced by Liberati et al., [21] and developed specifically for scoping reviews by Tricco et al., [22]. In particular, the PRISMA methodology was used to guide the description of the eligibility criteria, information sources, data collection process, data items, and synthesis of results.

First, a specification is made to determine what is included (Inclusion Criteria / IC) and not included in the criteria (Exclusion Criteria / EC) of the articles used. Inclusion Criteria: 1) Published from 2019 till 2022 2) Type of publication: Journal (research article) 3) Written in English 4) Articles could be accessed 5) Mention the intervention to improve teacher's digital competence 6) Empirical research. Exclusion Criteria: 1) Conference proceeding, systematic review articles, book series, chapter in book and books. 2) searching was conducted in three databases, Education Resources Information Centre (ERIC), Science Direct, Taylor and Francis Online. The combination of search terms was digital AND (literacy OR competence OR skill) AND teacher AND (training OR professional development). The search strategy focused on the abstract of each record. A total 431 records were found and screened. Of the 63 full-text articles, 50 articles were excluded, yielded 13 articles.

Results and discussions

Overview the articles

After completing our last review, we identified 13 articles related to TPD in enhancing digital competencies. Table 1 includes the 13 identified articles and a summary of the study framework, setting, timeframe, participants, grade level, subject, and country. Six of 13 articles (46%) reported TPD was conducted online, while two of 13 articles (14%) were conducted onsite, and only one was reported blended. However, there are no specific studies on whether the TPD is better online, onsite, or blended and how this affects the results. Moreover, the timeframe is diverse in duration. There were TPD that only took a few hours, but more TPD was carried out in days. Several TPD is continued until months or semesters for the implementation in class. The length of the training time depends on the objectives of the TPD.

Across the identified studies, there were more TPD participants from one particular grade level of education than participants of all levels of education (n=9). It also appears that there are more TPD where participants are grouped by subject compared to TPD conducted without subject restrictions (n=8). The TPD attended by participants from all grade levels or subjects usually consists of materials such as how to use tools or operate technological devices, how to use the LMS platform and utilize it for learning management, as well as materials aimed at helping the student in facing digital divide and preparing themselves as participants in a global, digital and democratic society. This topic does not depend on the grade or subject the teacher is teaching. Meanwhile, the materials for which participants are grouped by grade level or subject, for example, are how to develop technology-based learning tools and integrate technology into their subjects. Carrying out subject-specific or context-appropriate training is now a necessity. Teachers are found to have not been able to integrate technology into the learning process in the subjects they teach [23].

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Table 1 showed that most university lecturers do TPD. Apart from teaching competence, according to Caballe [24], the DC aspect that needs improvement is how to teach students to use technology appropriately. Despite today's students being digital natives, it does not guarantee that students are competent in all technological aspects. Their technological mastery is yet limited to technical aspects such as the use of multimedia and lack of using technology to acquire information and communicate.

Table 1. Summary of the articles

	Year	Author(s)	Setting	Time Frame	Sample	Level	Subject	Country
1	2019	Dorfman	Onsite	30 hours (4 days)	12	High School	Chemistry And Biology	Israel
2	2019	Gordillo	Online	20 hours (4 weeks)	236	All	All	Madrid
			Online	30 hours (6 weeks)	565			
			Online	30 hours (7 weeks)	78			
3	2019	Korkealehto	Blended	6 months	81	All	Language	Finland
4	2019	McCarthy	-	-	75	All	All	Australia
5	2019	Rosita	Online	-	18	High School	English, Math, Physic, & Biology	Indonesia
6	2020	Karunanayaka	Online	3 days	41	Secondary School	ICT, Mathematics, Science	Sri Lanka
7	2020	Martin	-	3 hours	45	K-12	All	USA
8	2020	Mahapatra	-	12 hours	16	University	Language	India
9	2020	Sultana	Online	-	100	University	All	Pakistan
					100	University		Indonesia
10	2021	Pongsakdi	-	3 hours	98	K-12	All	Finland
11	2021	Syafryadin	Onsite	2 days	10	High School	English	Indonesia
12	2022	Howell	-	24 hours (4 days)	15	Primary School	Language	USA
13	2022	Wannapiroon	Online	30 hours (5 days)	2233	University	Vocational	Bangkok

Moreover, the data admitted that elementary school teachers held the least TPD, indeed, their digital competencies mastery was also important at this level. The information management topic also mentions the material taught to students related to digital literacy. However, the depth of material is different considering that elementary school students use technology in learning to search for, use, and convey information [19]. Martin's findings strengthen the description of

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students' competence in using technology [25]. Even though students are currently close to technology, they still need to be given learning related to their role as digital citizens, such as the topic of digital etiquette, digital footprint, digital privacy, digital identity, and cyberbullying.

The implementation

According to most of the literature reviewed, we can divide the topics of TPD into three big categories. The first category is how to use digital-based devices or applications. For example, in Dorfman [26] & Syafryadin [27], teachers learned how to operate the tools or features of a video editing application. The second category how to use learning management platforms, such as the C-DELTA platform [28], MOOC [29,30], ViLLE Program [31], and Google Classroom [32]. Last category, 8 of 13 articles reported TPD is the competencies in pedagogic aspect, consisting of: 1) integrating technologies into learning, 2) managing learning in an online system, 3) creating learning material based on digital, and 4) teaching digital literacy to students [25], [27-30], [33-35].

The objective of TPD affect the activities. Therefore, from the activities, TPD can be categorized into five types, namely: 1) material delivery [25,31], 2) product creation [27], 3) practice and implementation [26,29], 4) discussion and evaluation [32], 5) implementation in class for months or semesters, and periodically evaluated and revised [28], [33-36]. According to those studies, the last type of TPD is applied most. In this category, teachers have more time to study. The experience received while practicing the training materials can be evaluated and improved collaboratively. There are more opportunities to receive comments, suggestions, or new ideas. The role of the coach and fellows can be obtained until the learning process ends. However, no research yet to determine the most preferred training category by the teachers.

The form of TPD is a combination of seminars, training, workshops, and coaching, where the activities arranged in it are also very diverse. Lectures, discussions, and presentations are carried out to learn things that are knowledge. Conducting need analysis, determining learning objectives, designing and creating learning products such as lesson plans, quizzes, digital video and animation, and implementing the TPD in class or peer teaching are carried out for skills matters. Furthermore, one-on-one meetings and feedback session activities were carried out to discuss the learning experiences and practices of the participants. In some studies, one-on-one meeting is an activity that is personalized and tailored to the needs of each participant, such as discussing things that are still unclear or obstacles encountered during practice. Another way to personalize the process is by involving teachers in setting goals for the TPD. This practice makes the participants become more active [37].

Furthermore, there is evidence that several countries have digital competency training programs. In its preparation, the government developed this program or in collaboration with universities [28,34,38]. It is a potential collaboration to develop a TPD program with a digital competence theme. By having a program, it provides an advantage in terms of being more effective and efficient because it can be used repeatedly. In addition, it can overcome inconsistency of the digital competency framework used in one country. Spante [39] explained that the inconsistency in understanding digital competence could badly impact measurements. It becomes less invalid and proposes no clear framework. When a country has its own program, it is more appropriate because it adapts to the conditions and characteristics of its users, reducing the appearance of obstacles. One example of the obstacle that appears in using programs from other countries is that

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participants have difficulty participating in the program because the teaching materials do not use their mother tongue but a second language [28].

Media and tools

The learning tools in this study are used as learning media or assessment instruments. The media found were video material and video tutorials, modules, multimedia, page links for supporting learning resources, and media that facilitated discussion forums, whether incorporated in an LMS or separately, such as the WhatsApp Group. TPD guidance (printed or electronic) is also required.

In addition, the learning tools used are for assessment. Assessment is carried out to determine the level of achievement of the training consisting of knowledge, skills, and attitudes. It also can be measured from the changes in motivation, self-confidence, and teachers' perception of technological innovation in learning. The assessment was carried out by observation during training, interviews, tests, product assessment, and implementation, even measured by the participants' achievement in completing the training module in the online course. Assessment can also be carried out by teachers themselves, given by other participants, practicing partners, and even students who taught as part of implementing the training.

Most of the studies developed their own instruments. However, some studies adapt existing instruments, such as an instrument to measure teacher confidence which was adapted from Graham et al., (2009) and Blonder et al., (2013) in the research of Dorfman et al., [26], skills in creating digital educational materials using the LORI (Learning Object Review Instrument) instrument adapted from Leacock & Nesbit (2007) in Gordillo et al., [29], and mastery of TPACK using a survey adapted from Archambault & Crippen (2009) in McCarthy [33].

Challenges and recommendation

This review found several challenges with its alternative solution as well as recommendation. It needs to be known to be better prepared for the following training.

First, some teachers found do not have the initial ability to operate a device or application, so it becomes an obstacle to making digital-based learning products. It was solved by providing video tutorials or preparing additional mentors to help participants who do not yet have the prerequisite skill [28,29]. It implies the importance of having a picture of participants' initial abilities and characteristics.

Besides understanding initial abilities, appropriate training is designed based on participants' needs. Previous studies showed that almost none of the teacher training materials in each study are precisely the same. This proves that the teachers' needs are essential to know. Five of them reported conducting observations, semi-structured interviews of the teachers, questionnaires for the teachers and students, and an analysis of teaching materials, syllabus, and assessment tasks as a step to analyze teacher needs [26,27,30,33,36]. Also, understanding the participants would help determine strategies when dealing with teachers who are less motivated to learn and use innovative technology in their learning. Sultana et al. [30] found that forum group discussions or meetings can be one strategy to overcome it.

The next challenge is the availability of facilities and time. As mentioned above, the materials are not only knowledge, so they require facilities that must be specially prepared, such as preparing devices with certain specifications. If the TPD is conducted online, it also requires stable networks. Time availability is also important, considering that the participants are teachers who already have teaching hours as their responsibility [26]. Karunanayaka & Weerakoon [28]

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explained the importance of school support in facing this challenge. Lindfors et al., [40], on their study, revealed that teachers' uninvolvement was caused by a shortage of time. Schools can lend facilities for teachers who need it, less the workload, and allocate time so that teachers can fully participate in training. Not only time for following the TPD, but also time to teachers to implement their digital skills in the classroom. Creating materials and products that require digital competence and teaching topics related to digital literacy requires time to prepare everything. If teachers are not assisted in providing time, it is reported that teachers tend to be reluctant to implement the results of TPD or only do it when there is time [30,35,36].

Another finding is the importance of providing feedback. Sultana [30] found that one of the reasons for the low participation of participants was the lack of feedback. Meanwhile, Korkealehto [34] concluded that the feedback received from the trainer or coach and fellow participants was very meaningful for the participants.

This research also indicates several recommendations for TPD. First, considering the scope of digital competence is quite broad and relatively new, it is hoped that TPD can be carried out many times on different topics [25,27,30]. This also been mentioned in Lindfors et al., [40], which emphasizes the need for continuing professional development (CPD). Second, besides TPD, there is a need for online discussion or regular meetings as a forum for sharing and learning from each other [30,32] as also found in Guilbaud's research [41].

Finally, the coaches' role, partners for learning, or colleagues to collaborate is highly expected because it also facilitates the learning process [33]. In addition to providing coaches, Howell, et al. [35] reported that instructing pre-service teachers from undergraduate courses to assist in-service teachers as technical support has a positive impact.

Conclusion

Digital competence affects the success of learning that involves digital devices. Therefore, the need to improve teachers' digital competence can be answered with TPD. TPD must have clear objectives accompanied by an introduction to the characteristics, needs, and initial capabilities of teachers' digital competencies.

The most presented type of TPD is accompanied by mentoring and carried out for a certain period. The participants were given a briefing at the initial meeting, followed by making products or preparing lesson plans to be further integrated into teaching, then continued by looking at learning outcomes or seeing student responses. This type has a longer duration of time and more energy but is more relevant and contextual. This type of TPD allows teachers to apply what they have received from the training immediately. Furthermore, the experiences gained when practicing is evaluated together and suggestions for improvement are given. Teachers can also learn and find inspiration from the real experiences of fellows.

As with all research, this report has its limitations. The literature focuses on the TPD that has been done. It has not been studied how teachers view TPD and the overall impact on teacher competence. Therefore, it is recommended to analyze the teacher's view of the existing TPD and develop a TPD model that corresponds with the teacher's characteristics. In addition, it is necessary to conduct a meta-analysis to determine the magnitude of the influence of TPD on digital competence.

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The effectiveness in implementation of blended learning based scientific on natural science learning outcomes

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Abstract. *This study aims to describe the effectiveness of the implementation of blended learning based scientific on the junior high schools of science learning outcomes in work and simple machine topic. This type of research was a quasi-experiment with a pretest-posttest control group design. The research population was all 8th grade students on 35th Junior High School, Medan academic year 2022/2022 that consists of 11 classes. The sample of this research was class VIII-10 as a control class with conventional learning and class VIII-11 as an experiment class with the implementation of blended learning based scientific, each with 32 students. Sampling used a simple random sampling. The research instrument used learning outcomes tests in the cognitive domain in multiple choice form with 4 choices of 20 questions that have been validated. Pretest was given before treatment and posttest after treatment. Based on the results of hypothesis test using t-test or difference test with SPSS 22. The results obtained that there are significant differences in learning outcomes with the implementation of blended learning based scientific approach compared to conventional learning, it means the implementation of blended learning based scientific approach was more effective to increase learning outcomes compared to conventional learning in work and simple machine topic. The percentage increase in N-gain student learning outcomes in the experiment class was 74% (high category) and the control class was 35% (medium category). The highest percentage increased in N-gain learning outcomes per indicator in indicator C-6 (create) of 79% (high category).*

Keywords: blended learning, scientific approach, learning outcomes

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Introduction

Advances in information and communication technology (ICT) or information and communication (ICT) have influenced various aspects of human life, one of which is the world of education. Sincerely this felt by the shift in learning patterns over time. Long before the COVID-19 pandemic struck, various countries in the world, including Indonesia, had started implementing ICT-based learning in the education system. The development of ICT requires creative and innovative teachers to be able present learning activities by utilizing technology such as e-learning. In connection with the development of ICT, e-learning is currently being developed in the world of education throughout the world, including Indonesia. The urgency of e-learning in learning in the era of the industrial revolution 4.0 provides color to the world of education [1]. One of the e-learning used is blended learning. Blended learning is a learning method that combines two learning patterns, namely by utilizing technology and learning through teaching staff in other words, blended learning is a type of learning that combines conventional methods (face-to-face) with teaching utilizing the development of information technology (online) [2-5].

The COVID-19 pandemic has damaged the order of all institutions, including education, especially schools are places where all students interact with the growth and development process. As a result of this pandemic, education immediately changed its learning patterns. The teaching and learning process has changed to an online system, usually through the zoom application, google classroom, and several applications that eventually created to help the learning process. With the presence of pandemic 19, the development of e-learning is increasing rapidly due to the restrictions on face-to-face learning globally [6]. The learning process must utilize technology in teaching [7]. One of the media used for e-learning is moodle. Moodle is a place of learning that provides various features that help the learning process. Modular object-oriented dynamic learning environment (Moodle) is computer software that functions to plan and implement the learning process [8-11]. Moodle provides various facilities such as attendance, big blue, utilizing meet or zoom, creating assignments & sending assignments, uploading teaching materials, and connecting teaching materials to Moodle facilities [10-12].

Since the COVID-19 pandemic, limited face-to-face learning has been implemented [1,13,14,15,16]. Limited face-to-face learning has a drawback in that learning time becomes limited, so the learning is carried out in blended learning. According to Bahri (2020) [17], the purpose of blended learning is to practice and attest in the classroom while face-to-face takes place as well as discussions in online class forums about the whole deepening of the subject matter, concepts, and laws obtained asynchronously. Both independent and collaboratively, their characteristics are being able to discipline themselves. The advantages of blended learning according to Thorne (2003) [18] include: 1) learning can be more directed, focused, and extended well in time, 2) learners can interact with educators, 3) learners can interact with their peers, 4) easily accessible learning materials, 5) various techniques can be exploited by maximizing technological differences and 6) are used outside of learning.

Science is the study of natural phenomena, facts, concepts, and laws that are verified through a series of observations and experiments [19]. At the junior high school level, integrated science learning is presented as an inseparable whole, meaning that students do not learn physics, biology, and chemistry separately as stand-alone subjects, but rather all designed in one unit in science learning. Along with the implementation of the 2013 curriculum, which emphasizes all lessons require a scientifical approach, including a science lesson. Learning with a scientific approach is learning that emphasizes the giving of experience directly, by the scientific method,

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starting with formulating problems, creating hypotheses, designing, evaluating evidence, testing hypotheses by experimentation, and concluding [20]. Activities of learning with a scientific approach through the process of observing, asking, trying, associating, and communicating [21]. Expected that this scientific approach can help a student develop and build knowledge through scientific methods and thus improve the achievement of study.

The science lesson should not have a significant obstacle in implementing a scientific approach as science dictates it. But based on observations in the field, this scientific approach is rare in the science-learning process, especially with the presence of covid-19 pandemic. This causes science learning outcomes to be lower. The reasons some teachers do not take a scientific approach include 1) there are too many science materials so that time runs out just to present the material; 2) insufficient facilities and infrastructure available in the school; 3) the limited ability of science teachers because they come from one family of knowledge only, and 4) limited learning resources. A scientific approach is increasingly rare, especially when a covid-19 requires online study.

An improvement should be made in the learning process, especially in the study of science, especially in the custodian condition of covid-19. One of the educational systems that could be used is the blended learning-based scientific approach. The application of blended learning with a scientific approach expected will affect students' learning. The learning results are a student's self-assessment and alterations that are observable, proven, and measurable in the abilities or achievements that students experience as a result of learning experiences [22].

Methodology

This study used quasi-experimental research with a pretest-posttest control group design involving two classes selected by simple random sampling. The population in this study were all 8th grade students on 35th junior high school Medan for the 2022/2023 Academic Year consisting of 11 classes. This study used two classes as samples, namely class VIII-10 as a control class using conventional learning and class VIII-11 experimental class with the application of scientific-based blended learning, each with 32 people. The free variables of this study were blended learning based on scientific approaches and variables were tied to student learning outcomes in the cognitive realm. Indicators of learning outcomes in the cognitive domain are C1 (remember), C2 (understand), C3 (apply), C4 (analyze), C5 (evaluate), and C6 (create) [23]. Cognitive domain learning outcomes were measured using multiple-choice tests of 20 valid questions (construct and field validation). Moodle is a learning management system (LMS) application used to improve the quality of blended learning. The data analysis technique of this study was analyzed using a t-test assisted using SPSS 20.0. Improved student learning outcomes using normalized gain scores (N-gain) [24]. The calculation of N-gain showed by the formula:

$$\langle g \rangle = \frac{\langle Sf \rangle - \langle Si \rangle}{100 - \langle Si \rangle} \times 100$$

Results and discussion

Results

The research was carried out in the odd semester of the 2022/2023 Academic Year in eight-grade at one of the State Junior High Schools in Medan on the Work and Simple Plane topics. The study

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was conducted during five meetings. The first and fifth meetings of learning are carried out offline. The second, third, and fourth meetings of learning are carried out online using the LMS-Moodle application. Web-based LMS-Moodle was used to provide features in the form of assignment submission, discussion forums, downloading learning tools (lesson plans, teaching materials, learning media in the form of PhET videos and simulations, quizzes, and test questions), and online announcements. Experimental and control classes are given a pretest to 64 respondents before the treatment. This pretest aims to determine whether the initial abilities of the two classes are the same or different. Posttest data were obtained after being given treatment to the experimental and control classes, each meeting five times. Offering the test aims to see the effect of the application of blended learning based on a scientific approach on learning outcomes in the experimental class and conventional learning in the control class. The pretest and posttest data showed in Table 1.

Table 1. Pretest and posttest data on student learning outcomes in control and experiment class

Test	Class	N	Minimum Score	Maximum Score	Average	Standard Deviation
Pretest	Control	32	20,00	55,00	37,18	9.279
	Experimental		15,00	55,00	38,12	12.040
Posttest	Control		40,00	85,00	59,21	2.288
	Experimental		65,00	100,00	84,06	2.117

N = the number of students

The pretest and posttest data of both classes were analyzed using a t-test assisted using SPSS 22.0 under the condition that data were normally distributed and homogeneous. The results of the normality test of the pretest and posttest data showed in Table 2. Based on the pretest and post-test data presented in Table 2, a signification value of > 0.05 was obtained so that normally distributed data.

Table 2. Normality test of pretest and posttest data on learning outcomes

Test	Class	Sig	Conclusion
Pretest	Control	0.146	Normal
	Experimental	0.151	
Posttest	Control	0.525	
	Experimental	0.093	

The homogeneity test aims to determine whether the sample class is from the same or different population. The tested of homogeneity test by using SPSS 22.0, and the results showed in Table 3. Based on the pretest and post-test data presented in Table 3, a signification value of > 0.05 was acquired, so it can be concluded both samples had the same variance or were homogeneous.

Table 3. Pretest homogeneity test of learning outcomes

Test	*Levene Statistic*	df1	df2	Sig	Conclusion
Pretest	0,066	1	62	0,798	Homogeny
Posttest	0,066	1	62	0,798	Homogeny

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Pretest and post-test data were analyzed using t-tests. The t-test was assisted using SPSS 22, and the results showed in Table 4. Based on Table 4, for pretest data, the sig (2-tailed) value is 0.748 > 0.05, so it can be concluded that the control and experimental class have the same initial ability. Based on Table 4, for posttest data, the sig (2-tailed) value is 0.000 < 0.05, so it can be concluded that there is an influence of the application of scientific-based blended learning on student learning outcomes.

Table 4. T-test of pretest and posttest data for second class learning outcomes

	Pretest		Posttest	
	Equal variances assumed	**Equal variances not assumed**	**Equal variances assumed**	**Equal variances not assumed**
F	0.625		0.070	
Sig	0.432		0.729	
t	-.322	-.322	-9.019	-9.019
df	62	59.578	62	61.630
Sig (2-tailed)	0.748	0.748	0.000	0.000
Mean deference	-0.938	-0.938	-24.8438	-24.8438
Std. Error difference	2.907	2.907	2.7546	2.7546

The percentage increase in student learning outcomes was calculated by normalized gains (N-gain). Data on the percentage increase in N-gain learning outcomes showed in Table 5. The percentage of improvement in learning outcomes of experimental class students is higher than that of the control class. The percentage increase in N-gain in learning outcomes of experimental class students was 74% (high category), and control class by 35% (medium category).

Table 5. Percentage of n-gain improvement in learning outcomes

Class	**Average of *Pretest***	**Average of *Posttest***	**N-gain (%)**	**Category**
Control	37,18	59,21	35	Medium
Experiment	38,12	84,06	74	High

Table 6. Percentage of N-gain improvement in learning outcomes per indicator

Learning Outcome Indicators	**Experimental Class**		**N-gain (%)**	**Category**	**Control Class**		**N-gain (%)**	**Category**
	Pre-test	**Post-test**			**Pre-test**	**Post-test**		
Remember (C1)	39,84	85,15	75	High	38,28	65,62	44	Medium
Understand (C2)	50,78	87,50	74	High	41,40	69,53	48	Medium
Apply (C3)	23,75	82,50	77	High	26,25	38,12	16	Low
Analize (C4)	27,08	77,08	68	Medium	40,65	60,70	33	Medium
Evaluate (C5)	47,91	87,50	76	High	53,12	66,66	28	Low
Create (C6)	25,00	84,37	79	High	12,50	50,00	42	Medium

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The percentage increase in N-gain learning outcomes per indicator of the C1-C6 of both classes showed in Table 6 and Figure 1. Based on Table 6, it can be seen that the percentage of improvement in N-gain of learning outcomes per indicator of the experimental class was higher compared to the control class. Based on Table 6, the highest percentage increase in learning outcomes in the experimental class on indicator C6, at 79% (high category), and the lowest is in indicator C4, at 68% (medium category). The highest percentage increase in the control class on indicator C2 was 48% (medium category), and the lowest in indicator C3 was 16% (low category).

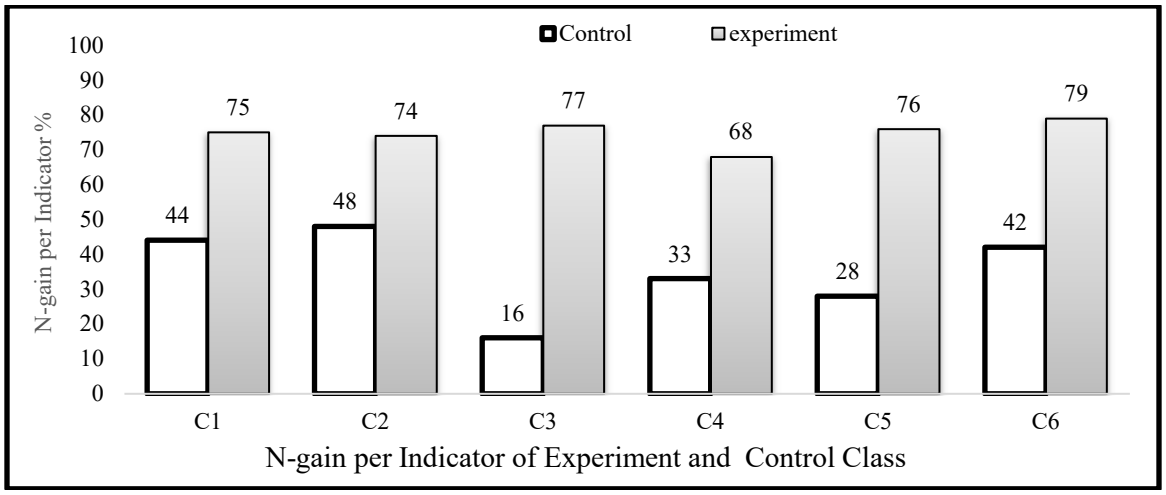


Figure 1. Percentage of n-gain improvement per student learning outcome indicator

Discussion

The introduction to LMS-moodle and the creation of each student's moodle account were carried out before the pretest. Moodle accounts are used during online meetings, where students are invited to log in to moodle via https://sekolsmp35medanipa.edukati.com link using the user and password that has been registered by the admin. The flowchart display of the LMS-moodle design showed in Figure 2.

This research is the application of blended learning based on a scientific approach to student learning outcomes in the cognitive domain. Before learning the pretest was given to both classes. The average pretest of learning outcomes in the experimental class was 37.18, and the control class was 38.12. The learning was carried out in five meetings with the respective sub-materials: 1) Effort and Power; 2) Types of Simple Planes (Pulleys and Axle Wheels); 3) Types of Simple Planes (Tilted Plane and Levers/Levels); 4) Mechanical Gain, and 5) Simple Plane Principle on Human Muscles and Skeleton.

The first and fifth meetings are offline, and the second, third, and fourth meetings are online. Each meeting follows the discovery learning syntax in order of 1) problem statement; 2) problem statement; 3) data collection; 4) data processing; 5) verification; and generalizations. After five meetings, posttests were given to both classes. The experimental class averaged a posttest of 84.06 and a control class of 59.21. Based on the results of the t-test, Sig (2-tailed) (0.000) <0.05 means that there is an effect of applying blended learning based on a scientific approach to student learning outcomes in science learning on Work and Simple Plane topics. In other words, the application of blended learning based on a scientific approach is better than

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conventional learning on students' science learning outcomes. Supported by Bahri (2020) found that scientific-based blended learning can increase student independence and learning outcomes in the Physics II Curriculum Study course. Bahri (2020) [17] also found that the higher the student's learning independence, the higher the learning outcomes. Supported by Tika et al. (2021)[25] found differences in learning outcomes and scientific attitudes in science learning with the application of blended learning compared to conventional learning. Anthony (2019) [26] dan Fitrieyah (2021) [27] found that blended learning affected learning outcomes. Furthermore, Anthony (2019) [26] stated with the application of blended learning at the elementary level in thematic learning, the learning process is better than conventional learning, the time is more flexible, providing practice questions which, if answered by students, will be directly assessed so that it has an impact on student learning outcomes. Budiastra et al. (2021) [28] also found the application of blended learning in science learning can improve science process skills and learning outcomes.

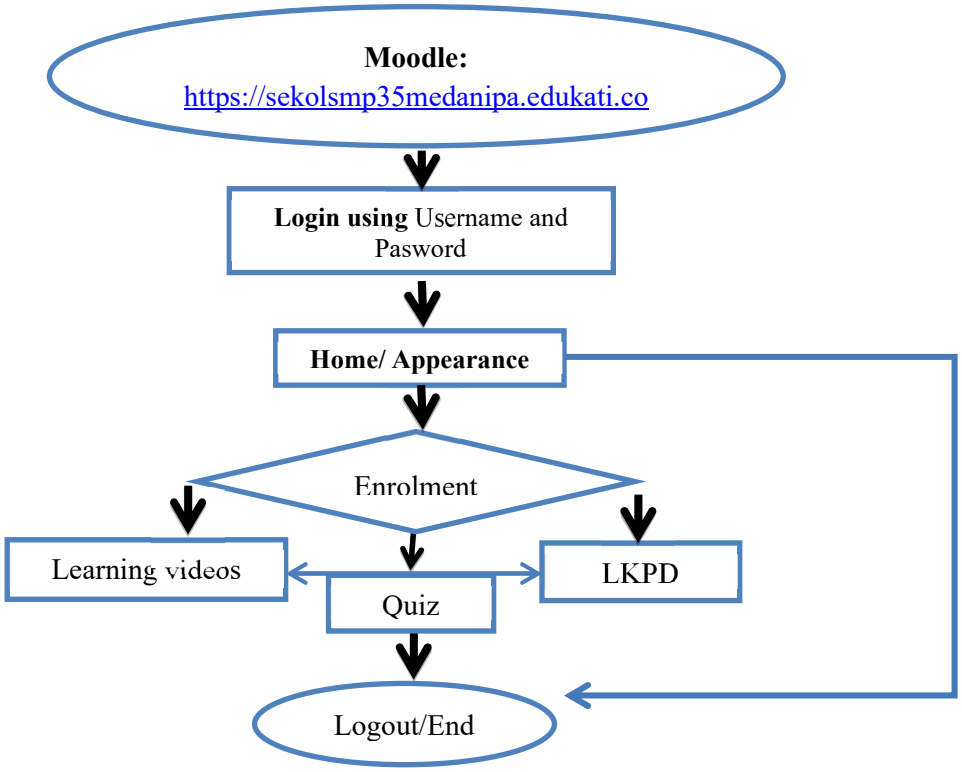


Figure 2. Moodle display design flowchart

Online learning using LMS-moodle. A display of LMS-moodle features is provided to aid the learning process shown in Figure 3. Some of the display features commonly used in this learning process are assignment, attendance, book, chat, file, folder, forum, URL, and quiz. The researcher designed the class on moodle, presented in Figure 4.

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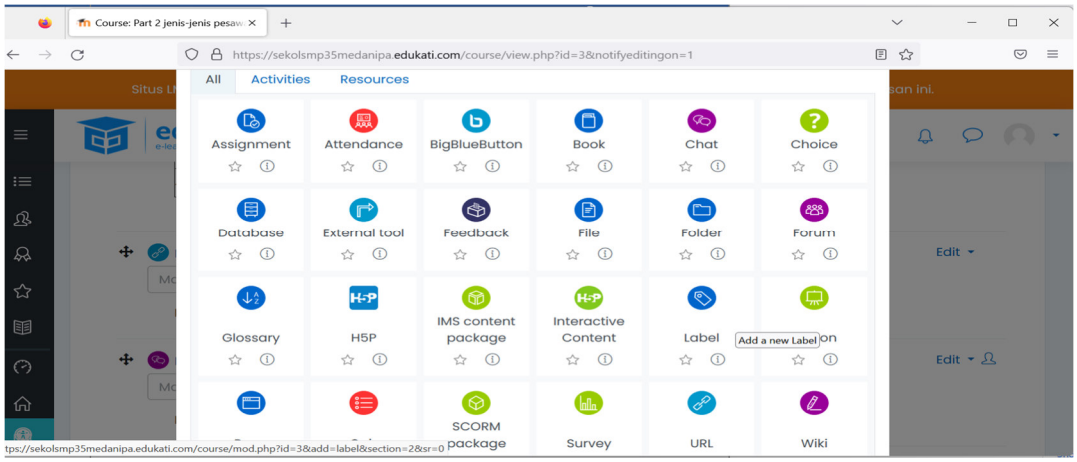


Figure 3. LMS-moodle features



Figure 4. Class display on moodle

The application of blended learning with a scientific approach is combined with the application of discovery learning at every meeting. The first meeting was conducted offline, reviewing the Effort and Power sub-material. The researcher gave a stimulus in the form of a question: "What plants around you, can the plants around you move?" The researcher showed a learning video about plant growth, then the students observed it. In the problem statement stage, the researcher asked the students: Does every moving plant work? In the next stage of collecting data, students form groups and prepare tools and materials to experiment/try according to LKPD-1 on Effort and Power. Students make observations before conducting further experiments. Students ask how an object is said to do work. Students collect experimental data. In the data processing stage, students analyze the data obtained from the results of the experiment and conclude it. In the verification stage, students communicate their findings in front of the class and other groups respond to them. At the generalization stage, the researcher reinforces effort and power and directs students to conclude. The conclusion obtained by the students was that "Effort

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is related to power". At the end of the lesson, the researcher directed the students to read the material for the next meeting and gave greetings. For the first offline meeting, students began to be interested in the learning process, because students were invited to do simple experiments with a scientific approach. Students actively construct concepts or principles through stages of observing, formulating problems, proposing or formulating hypotheses, collecting data with various techniques, analyzing data, drawing conclusions, and communicating concepts, laws, or principles found[29-30]. Furthermore, Nurkholis (2019) [29] stated scientific approach was highlighted in the fulfillment of the 2013 curriculum with student-centered learning that can make students creative and learning outcomes. Implementation of a scientific approach can improve learning outcomes to assemble students more active and easier to direct [31-32].

The second meeting was held online using LMS-Moodle as a place or learning tool. Previously, the researcher directed students to join via the zoom link https://us04web.zoom.us/j/5626401719?pwd=UTJTS0o4S3FPczIUWIdtN2huUTMxZz09 which is available on LMS-Moodle. At the beginning of the lesson, the researcher gave a stimulus through a learning video regarding the Types of Simple Planes in the form of applying pulleys and axle wheels in everyday life. In the problem statement stage, the researcher asked questions the form: Why do builders use pulleys to lift building materials, and why do bicycle wheels spin easily? In the data collection stage, students were directed to conduct experiments at home according to the steps on the student worksheets. As for the experiment, students observe the wheels of a bicycle or motorcycle around it. Students observe and investigate the part of the wheel called the axle. In the data processing stage, students are directed to process data and report it through the chat room available on LMS-Moodle and discuss it. In the verification stage, students communicate their findings, and other groups proffer to respond. In the generalization stage, the researcher provides reinforcement and directs students to conclude from what they have learned. After that, students were directed to take quizzes on LMS-Moodle. In this second online meeting, students were more interested in the learning process because students were allowed to watch learning videos, conduct simple experiments, and join discussions with their friends and other groups under the direction of the researcher. Most of the students actively asked for things they didn't understand. The application of blended learning based on a scientific approach using LMS-Moodle can improve learning outcomes because it has advantages such as providing compelling features, such as 1) quizzes that are done repeatedly and the results are immediately visible; 2) the existence of an assignment column makes it easier for students to collect assignments, and teachers simply check 3) various learning media such as videos can be accessed easily, and can open PhET simulation links that make students motivated to learn science; 4) the material is presented in the form of teaching materials and ppt, which are easily accessible; 5) discussion and chat forums that allow students to ask questions and discuss; 6) and other features that can be accessed anytime and anywhere so that students are more active and interested in learning science more deeply. Supported by Simanullang & Rajagukguk (2020) [33] found that with LMS-Moodle, students were very active in learning because of the Moodle features and a good atmosphere. According to Egorov et al. (2021) [34], students are more active in interacting and communicating because of the features in the form of discussion forums, quizzes, assignments, and wikis in learning using LMS-Moodle. Zabolotniaia et al. (2020) [35] stated that blended learning by applying LMS-Moodle would be more effective, and comprehensive through extensive educational content, and controlling, monitoring, and evaluating the quality of knowledge. The application of LMS-Moodle is effective when learning is useful in improving language skills, training critical thinking, and

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practicing ICT skills so that it can increase student productivity [36]. The application of blended learning using LMS-Moodle significantly improves learning outcomes compared to virtual learning alone [37].

The third meeting was held online using LMS-Moodle. The material studied is about the types of simple planes in inclined planes and levers/levers. The learning process at the third meeting was similar to the second meeting. The stimulus given is the application of simple machines in everyday life. In the problem statement stage, the researcher asked questions in the form: "There are tools in the form of hands, knives, and scissors, with which cloth is it easier to cut, and why with these tools, the cloth easier to cut?" Some students can answer correctly, and some still seem hesitant to answer in the chat room on LMS-Moodle. In the data processing stage, students conducted a simple experiment on the types of simple planes on an inclined plane and a lever that had been written on a student worksheet available in LMS-Moodle. Students are directed to cut the cloth with various tools around them (tweezers, knives, and scissors) and then observe what happens. Verification stage, students communicate their findings and discuss them in the chat room. In the generalization stage, researchers reinforce by showing learning videos and directing students to conclude from what they have learned via the zoom link https://us04web.zoom.us/j/5626401719?pwd=UTJTS0o4S3FPczIUWIdtN2huUTMxZz09. At the end of the lesson, the researcher directed the students to work on the quiz provided in LMS-moodle and closed the meeting with greetings. The graphical display of students when taking quizzes through Moodle showed in Figure 5.

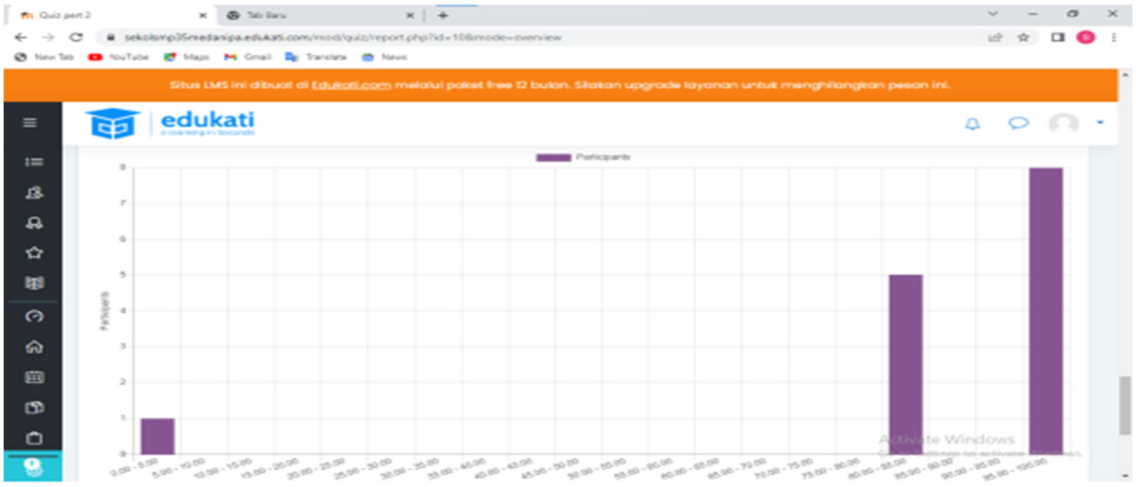


Figure 5. Student quiz results available on moodle

Learning at the fourth meeting was conducted online through Moodle. The material studied is about "Mechanical Advantages". The learning stage in the fourth meeting is identical to the second and third meetings. As for the differences, at the fourth meeting, the learning medium using the PhET simulation of Mechanical Gain was presented in Figure 6. Students conduct experiments virtually through the internet network. In the fourth meeting, students are more active and more enthusiastic about learning, and the discussion process is smooth. The percentage of students involved is increasing, and the quiz results are getting better than in previous meetings.

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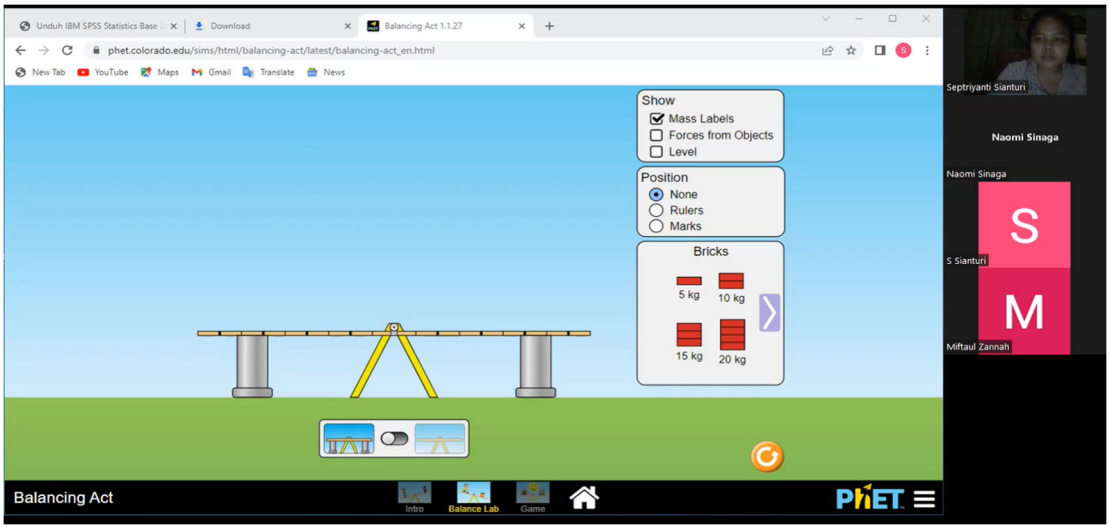


Figure 6. Impression of phet simulation

The fifth meeting was held offline. The material studied is "The Principles of Simple Planes in Human Muscles and Skeletons". The stages of learning at this meeting are identic with the first meeting. Students begin with a video treat about Athletes playing badminton. Students are directed to observe the muscles of the athlete. Students then collect data through experiments, analyze it, communicate, and infer their findings. The learning process at the fifth meeting is getting more active, the atmosphere is livelier, and students are more enthusiastic about participating actively. This makes students' understanding of the concepts learned deeper, and is supported by quiz results that are even better than previous meetings.

The application of blended learning based on a scientific approach assisted by LMS-Moodle has proven to affect student learning outcomes. The existence of LMS-Moodle allows students to learn anytime and anywhere with diverse learning resources, and learning media is more interactive to make students more motivated to learn, especially since the learning media explains science concepts in real life. Learning outcomes are improved by using learning Moodle [38]. The application of blended learning based on a scientific approach is helpful to make it easier for students to learn by utilizing cell phones and familiarizing students with an understanding of learning using the scientific method, so learning has a significant influence on student learning outcomes.

Based on the results of study, the average learning outcomes obtained from the pre-test in the experimental and control class were 38.12 and 37.18 respectively. The average post-test obtained in the experimental class was 84.06, and the control class was 59.21. The percentage increase in the N-gain of experimental class learning outcomes was 74% in the high category and the control class 35% in the medium category. Ningsih dkk., (2017) [39] stated that the application of blended learning is better at improving student learning outcomes than conventional learning in the Statistical Methods course. The application of blended learning using Moodle continuously can improve student learning outcomes to high categories [40]. Supported by Ertikanto et al. (2019) [41] stated that a scientific approach based on blended learning is effective, efficient, and able to improve learning outcomes seen from the value of students who have passed the Minimum Completeness Criteria (KKM) and can improve their higher-order physics thinking skills. Blended learning assisted by e-worksheets affects student learning outcomes. Firman et al. (2018)[31] state

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that the scientific approach can influence student learning outcomes in economics lessons. In line with the research of Widiyanti dan Nisa (2021)[42], stated scientific approach has a significant influence on science learning outcomes, namely by getting students to think, behave, and work with scientific rules and steps.

The percentage of improvement in N-gain of learning outcomes was reviewed per indicator, highest in the experimental class on indicator C6 of 79% in the high category. This is because, in every meeting, the learning approach used is scientifically based. In the application of a scientific approach, students are directed and guided to carry out scientific activities by designing, carrying out simple experiments, collecting and analyzing experimental data, and communicating them, both offline and online meetings. The highest percentage increase in the control class in the C2 realm was 48%, with the moderate category. Because at each meeting, teachers are more dominant in explaining concepts and giving examples of the application of simple aircraft in everyday life.

Conclusion

The application of blended learning based on a scientific approach affects the science learning outcomes of 8th grade students on Work and Simple mechanic topics. This means that students' science learning outcomes in the application of blended learning based on scientific approaches are better than conventional learning. Percentage increase in N-gain learning outcomes in the high category.

Acknowledgments

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Preservice science students' ability in constructing assessment of photosynthesis based on bloom, krathwohl, and dyer's taxonomy

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Abstract. *Evaluation is one of the most important components of teaching learning. Cognitive assessment became familiar for teacher because of its implementation in every part of learning, however there still lack of teacher who have good skill in constructing affective and psychomotor domain assessment. The need for skill in arranging integrative cognitive, affective and psychomotor has become challenge for teacher. This study aims to analyze and pre service science 's ability in arranging three domains of assessment on the topic of photosynthesis. About 93 pre service science students were involved in this study. Through administered 6 essay test item, then analyze quantitatively and qualitatively, result show average score respectively about students ability in arranging assessment: arranging cognitive test based on Bloom taxonomy (78.6), arranging affective statement based on Krathwohl taxonomy (77.8), arranging rubric of practicum evaluation based on Dyers taxonomy (72.8), students perception about evaluation (78.5), students perception about higher order thinking skills (85.1), students perception about good evaluation characteristic (78.7). Total average score of all essay test showed 78.58 that is categorized as good. It implies the important of increasing students' ability in arranging various science assessment that integrated three domains of cognitive, affective, and psychomotor.*

Keywords: assessment, affective, cognitive, photosynthesis, psychomotor

Introduction

One of teacher competence is evaluation skill in teaching process. This competence is related to teacher role and responsibility to evaluate instruction. Begin with basic evaluation skills into higher order evaluation skill, is prerequisite for teacher. Science learning is implemented through various strategy, method, and relevant learning media, then various evaluation technics. So, evaluation skills will complete teacher professionalism.

The taxonomy framework of educational objectives is used for classifying and formulating statements of student's achievement as a result of teaching. The framework provide ways for pre service students to practice designing test items at higher education in order to create banks of

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items. Benjamin S. Bloom have initiated and promoted the idea of Taxonomy of Educational Objectives which is published in 1956. The framework revision subjected to this issue of Theory into Practice, was developed in much the same manner at 2001. [1]. Benyamin Bloom saw the original Taxonomy as more than a measurement instrument. He believed it could function as a: a) formulation about learning goals to facilitate interaction among persons, subject matter, and grade levels; b) foundation for identifying a particular course or curriculum concerning specific meaning of broad educational goals, such as those found in the current national curriculum, state, and local standards; c) basic for determining the congruence of educational objectives, activities, and assessments in a unit, course, or curriculum; and d) dynamic range of educational possibilities facing limited breadth and depth of any particular educational course or curriculum which could be differentiated [2]. There are some procedures to analyze result of test to make sure whether educational objectives have been achieved by students [3-5].

Photosynthesis is a physiological process happen in plant and other organisms, commonly has chlorophyll, to convert light energy into chemical energy, through cellular respiration where it can later be released to fuel the organism's activities. Some of this chemical energy is saved in carbohydrate molecules, includes sugars, starches which are synthesized from carbon dioxide and water through phases of light and dark reaction during photosynthesis. Most plant, such as the family of algae and cyanobacteria also perform photosynthesis called photoautotroph. The process of photosynthesis is mainly responsible for producing and maintaining the oxygen content of the Earth's atmosphere, and supplies most of the energy necessary for organisms life on Earth both for human and animal as well [6,7]. The essential concept of photosynthesis is taught into various level of students begin with elementary, secondary, until higher education. So that the evaluation of its achievement needs specific skills for pre service students.

Methodology

This study aims to analyze pre-service science ‘s ability in constructing three domains of assessment on the topic of photosynthesis includes cognitive, affective, and psychomotor domain. About 93 pre-service science students were involved in this study. The essay items were designed by referred to basic competences to analyse concept of energy, various sources of energy, and energy changes in daily life include photosynthesis and to present result of experiment of energy change includes photosynthesis.

Table 1. The structure of essay test

Basic Competency	Essay Test
To analyse concept of energy, various sources of energy, and energy changes in daily life include photosynthesis	1.Create 6 multiple choice item based on Bloom Taxonomy consist of 6 level of thinking skills respectively from lower into higher order thinking skills: knowledge, comprehension, application, analysis-synthesis, evaluation, and creation 2. Create 5 affective statement completed with Likert scale based on Krathwohl Taxonomy consist of 5 level of attitudes respectively: *receiving, responding, valuing, organizing, and characterizing*
To present result of experiment of energy change includes photosynthesis**.**	3.Create evaluation rubric for photosynthesis practicum based on scientific approach according to Dyers Taxonomy consist of activity phases : observing, questioning, collecting data, associating, and communicating

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	4.Promoting students' conception about why science evaluation should be administered integrated include three domains of cognitive, affective, and psychomotor. 5.Why does Higher Order Thinking Skills (HOTs) important in learning science? 6.Promoting students conclusion about characteristic of good science evaluation

Through administered 6 essay test items, then analyze quantitatively and qualitatively. Students answer were classify respectively from scientific into naïve answer or from higher into lower score. Data of students answer for item 1-3 is displayed on figure 1, while

Results and discussions

The result of pre service science students' ability in constructing three kinds of assessment on the topic of photosynthesis can be seen as follow.

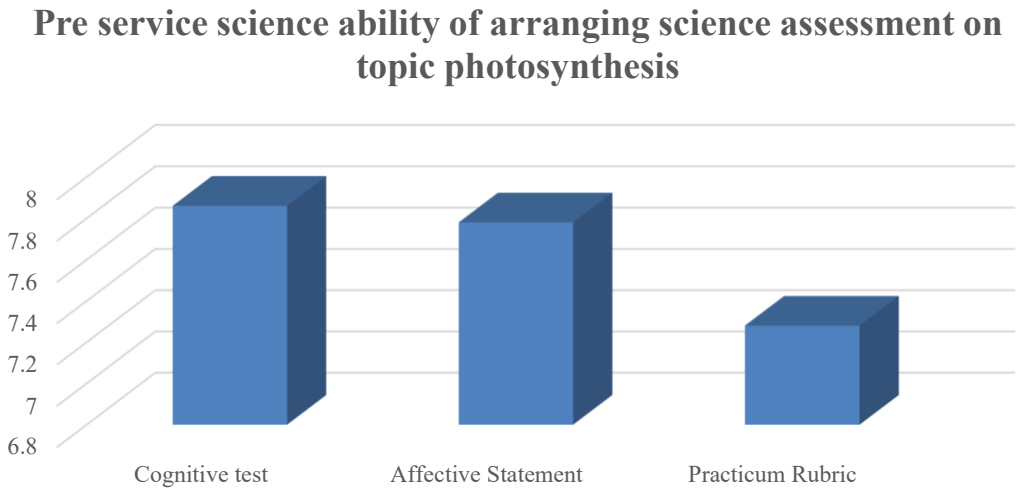


Figure 1. Pre-service science ability of constructing science assessment of photosynthesis based on Bloom, Krathwohl, and Dyers Taxonomy

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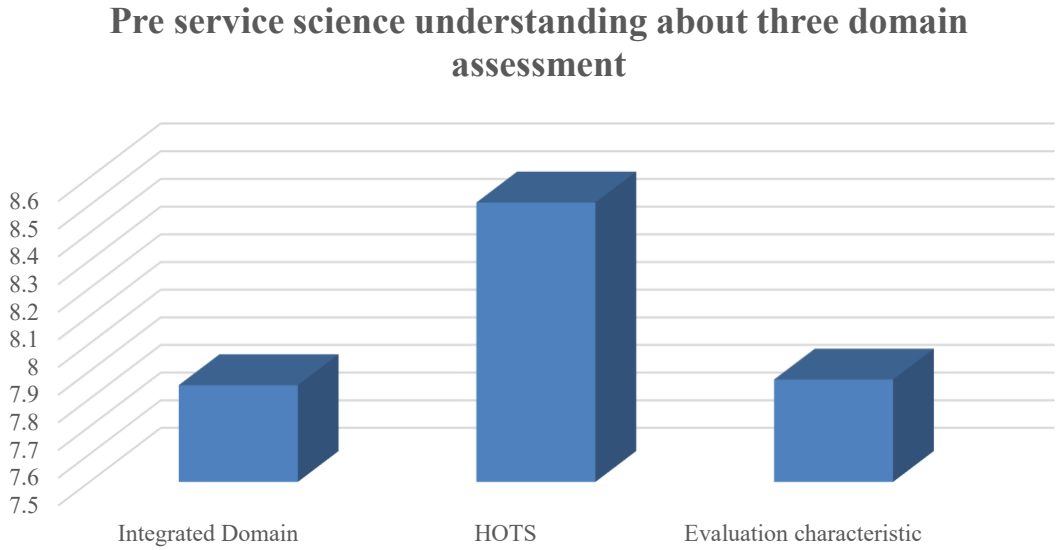


Figure 2. Pre-service science conception related to integrated domain, HOTs, and evaluation characteristics

Average score respectively about students' ability in arranging assessment from higher to lower: constructing cognitive test based on Bloom taxonomy (78.6), followed by arranging affective statement based on Krathwohl taxonomy (77.8). Students' difficulty in constructing cognitive assessment is on C4 (analysis)-C5 (evaluation)- and C6 (creation). Preservice science students' ability in arranging rubric of practicum evaluation based on Dyer's taxonomy is (72.8). They are still lack of good comprehension of practicum procedure.

Not only students' ability in constructing science assessment were assessed, but also others aspects that important in evaluation such as students' perception about evaluation (78.5), students' perception about higher order thinking skills (85.1), students' perception about good evaluation characteristic (78.7). Most preservice science students perceive the important of higher order thinking skills in science assessment, because this will stimulate students to think higher to solve problem. Next time students will have ability to solve problem both in their academic and daily life. HOTs test can be implemented to develop critical and creative thinking. It can extend the range of reason of one concept, so that students can have space of broader analysis [8]. Teacher commitment is highly needed to implement HOTs in all level of education. Through high commitment, high achievement will be successful.

Inquiry-based curricula support teacher with much different role in teaching rather than conventional curricula which provide direct teaching approaches typically used. For example, traditional science teaching would usually begin with lecturing, followed by administered worksheets and reading, and an occasional practicum to verify what was said or read. Standards-based science teaching would be in almost the different sequence which begin with engaging inquiry by using teaching materials, followed by discussion and then explanations. It would be helpful for teacher if curriculum include an extensive guide to assist teachers in making this change of instruction approach. These teacher guides should explain general strategies, and completed with steps of the student activities in the curriculum [9]. The best way for teacher to keep evaluative

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decision in teaching depends on evaluation process supported with research, transparent and implemented universally [10].

Conclusion

Pre service science students' ability in constructing science assessment of photosynthesis was categorized as good (average score 78.58). Among three domain, practicum rubric needs more practices and need more understanding about important of integrated domain. it implies the important of increasing students' ability in arranging various science assessment that integrated three domains of cognitive, affective, and psychomotor in order to have better acquisition of evaluation in science learning.

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Green digital marketing: feasibility of project based learning module to promote science pre-service teachers' entrepreneurial skills

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Abstract. *In the era of globalization, everyone must have high selling points and qualified skills in order to face intense competition in the next few years. One way to make it happen is to apply entrepreneurial learning in schools. One method to practice entrepreneurship skills is to apply Project Based Learning which is guided by an appropriate learning module. This study aims to develop a Project Based Learning module to train entrepreneurship skills to promote Science Pre-Service teachers' entrepreneurial skills. This module also facilitates students to learn more about green digital marketing. The design of this research is a backward design that focused on learning objectives as a result of instruction before design a plan for learning activities and teaching methods. This research also involved expert validators and practitioners to review module format, language, and content. The results show that the module has been developed is feasible to be used in entrepreneurship classes for science preservice teachers. It can be concluded that this module can be applied in class to promote entrepreneurial skills.*

Keywords: green digital marketing, PjBL module, entrepreneurial skills, science pre-service teacher

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Introduction

In this 21st century, everyone must have selling points and quality skills to face the challenges of the next few years, such as globalization, the acceleration in innovation and technology, and the adaptation of these technologies in daily life [1]. Graduates are not only equipped with academic knowledge and skills, but also need skills that can improve their work abilities, such as information receptive and processing skills; communicating and presenting skills; planning and problem-solving skills; and social development and interaction skills in society [2]. One way that can be done is by implementing entrepreneurial education and training that provides opportunities for individuals to practice these abilities. This includes providing related knowledge and experience on business management, marketing, information systems, and finance [2]. In addition, in this information age, the industry will have dynamic needs. According to Tony Dolphin [3], changes will cause dislocations and disruptions in the labor market, as a result there will be a change in the types of jobs that will be available and the skills required in the world of work. New career and profession will also appear in the future that demand individuals with entrepreneurial, scientific, creative, and emotional abilities [1,3].

Meanwhile, according to the Vice President of the Republic of Indonesia, Ma'ruf Amin, a country is said to be a developed country if 10% of its population are business people [4]. Based on the 2018 Entrepreneurship Global Index, business actors in Indonesia are still relatively low, which is only around 3.1%, when compared to the total population in Indonesia [4]. Thus, an effort is needed to encourage the next generation to develop their potential in competing in the global market with entrepreneurship skills.

Ciputra suggested that entrepreneurs can be formed in 3 ways, namely ‘since born’, formed by the environment, or through training [5]. The word ‘since born’ means that a person becomes an entrepreneur because his parents are also entrepreneurs. The second, ‘formed by environment’ means that the person is not born from entrepreneurial parents, but is often involved in the entrepreneurial environment. As a result, the person trains his entrepreneurial spirit. Finally, an entrepreneur is formed through practices and experiences. It shows that someone who is trained and given the experience of being an entrepreneur will direct himself to become an entrepreneur.

In higher education, entrepreneurship learning which involves business actors as role models has the possibility of having a positive effect on the entrepreneurial attitudes [5]. Entrepreneurship education in higher education has an important role in producing young people who have an entrepreneurial spirit [6]. One of the programs designed by the government is the *Merdeka Belajar* Program with five different themes. One of those namely Entrepreneurship them Community Service Program. This program is designed for one semester to train students, which are science pre-service teachers, to become entrepreneurs by working with businessmen as real work college partners.

One of the methods in entrepreneurship education that can be done in a Community Service Program is to apply Project-Based Learning [6,7]. Through this method, students are trained to become entrepreneurs by directly experiencing how to run a business. Students will assist and cooperate with partners during lectures where real work takes place in developing businesses in innovative ways, including digital marketing.

This is in line with the needs of real work college partners, namely the SME "Daun Efek" who are engaged in the eco-print product. SME “Daun Efek” owners stated that they still need help in digital marketing. Digital marketing is the main concept of marketing which includes the sale of services and goods via the internet [8]. Digital marketing helps reach the target market to

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analyze market needs to promote goods and services through digital platforms [8]. The system of digital marketing makes business run faster and more accurate [9]. It is also more affordable than traditional offline marketing methods [9].

In addition, marketing also needs to apply the concept of green marketing. The concept of green marketing is a relatively new concept. This concept involves the promotion of environmentally friendly products and services. This green marketing includes development, manufacturing, promotion, distribution, consumption, and disposal of products and services so as not to cause damage to nature [10]. Business organization are increasingly aware of the importance of green marketing to gain an advantage over competitors [11]. This is because many consumers are starting to realize the importance of protecting the environment from the products and services they use. By implementing green marketing in a marketing strategy, it will generate positive values for the company's image and benefits that are important to society [12]. The more companies can make innovative environmentally friendly products, the more positive the company's image in the eyes of consumers [13].

Therefore, a study was conducted which aimed to determine the feasibility of the entrepreneurship learning module by applying the Project-Based Learning method. This module will be used for students programming real work courses. This learning module contains material regarding entrepreneurship that applies environmentally friendly principles accompanied by exercises based on the experience of partner, namely the SME “Daun Efek”. The project that will be carried out by students leads to the marketing of environmentally friendly products produced by the partner. Feasibility is described in terms of content, construction, and understanding aspects. The importance of this research is to provide modules that can utilize the entrepreneurial spirit needed by science pre-service teachers after they graduate. Entrepreneurial education can also cultivate unique skills and think outside the box. Although these skills are not necessarily relevant to an entrepreneur's career, it will foster an entrepreneurial attitude that leads students to excel in school and throughout the school year.

Methodology

The design of this research is a backward design that focused on learning objectives as a result of instruction before design a plan for learning activities and teaching methods. This research has three stages. The first stage is knowing the results of learning. This phase aims to analyzing common content to teach and develop instructional goals. This stage also aims to review the scope and order to be taught. Some essential questions to recognize are "what should students be able to do, know, and understand at the end of the instruction?", "what content should be taught?", "in what order should the content?", and "what lasting understanding is desired at the end of the teaching?". Stage 2 decides on acceptable evidence of student learning and proficiency before deciding how those knowledge and skills are to be taught. For example, evidence can be gathered through tests, exams, projects, etc. Assessment must be adjusted with expected learning goals. Some essential questions to consider for this stage are "How will teachers know if students will achieve the desired outcomes?" and "What is acceptable evidence for student achievement?". The third stage is planning learning experiences and instructions. These activities should help to create clear teaching objectives while redirecting back to the assessments made in previous stage. Some questions to consider are "What knowledge and skills do the students to perform effectively and achieve the desired results?", "How the learning The activities selected help students acquire knowledge and skills?", "How should the skills and knowledge being assessed”, and “What

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materials and resources are needed to meet my teaching goals?". This research also involved expert validators and practitioners to review module format, language, and content.

The module for this Community Service Program students is consisting of material about entrepreneurship education. It also provides some practice to utilize students' entrepreneurship skills related to products and services that eco-friendly. In designing this module, it referred to the understanding by design framework stages.

After the module were compiled, the module was then validated by three science experts and also entrepreneurship education. The results of the validation become material for revising the module. Next is to validate the module to three experts of natural science education and also entrepreneurship education. The validation results are the source for revising the module. The module that has been compiled will be be used during Community Service Program. Each aspect of validation is evaluated base on the validity rating scale in Table 1.

Table 1. Scale of validity rating

Rating	Score
Very good	5
Good	4
Enough	3
Less	2
Not good	1

Data validity was analyzed by using descriptive quantity analysis. Data is calculated by the average score given by the validators. Values are describes qualitatively based on the assessment criteria presen

The validity data were analysed using quantities descriptive analysis. The data is calculated by averaging the score given by the validators. Values are described qualitatively according to the assessment criteria conferred in Table 2.

Table 2. Criteria for module assessment category

Score interval	Category	Description
$4{,}2 \leq S \leq 5{,}0$	Very valid	Usable with minor revision
$3{,}4 \leq S \leq 4{,}1$	Valid	Usable with some revisions
$2{,}6 \leq S \leq 3{,}3$	Enough	Usable with multiple revisions
$1{,}8 \leq S \leq 2{,}5$	Less valid	Usable with so many revision
$1{,}0 \leq S \leq 1{,}7$	Not valid	Cannot be used

Results and discussions

The module developed contains Core Competencies, Basic Competencies, and Achievement Indicators; Concept Map; Five topics (Green Products, Green Packaging; Green Marketing; Digital Marketing; and Green Digital Marketing); Discussion Activities Feature in each topic; Project Activities; Summary; Glossary; Exercise; and Reference. Table 3 shows the feasibility result of the module. Feasibility is assessed from the content, construction and understanding aspects. Validity is decided by the result of validation by three validators (three lecturers of Science Education of Universitas Negeri Surabaya who are experts in Science Education and Entrepreneurship Education).

Table 3 indicates that module validation results for each aspect are in the range of 4 to 5. This means that the module is in a very valid category. The result of reliability is 86% to 100%

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which indicates that the assessment between validators has a good match. However, validators also suggest some minor improvements to the module.

In terms of content, the module contains green marketing and digital marketing concept. It also provides reading activity equipped with some examples from SME Daun Efek activity. Thus, students can understand more about green product, green marketing, and digital marketing. The activities on the module also facilitate students to analyse real situation happen on SME Daun Efek. These activities may give students more knowledge and experience of the real world of entrepreneurship. Including local entrepreneurs in the entrepreneurial education process, such as inviting entrepreneur take part in question-and-answer sessions with students, present their success experiences, and shares their obstacles to reach the success can give student clearer sense or the real world of entrepreneurship and better understanding of the challenges and opportunities may be faced by entrepreneurs [14].

Table 3. Module validation results

No.	Validation Aspect	Average	Category	Reliability (%)
I. Content				
1.	Module contains green marketing and digital marketing.	5	Very valid	100.00
2.	Module contains aspects of project-based activity.	5	Very valid	100
3.	The equipment and materials needed in these activities are realistic to implement.	4.67	Very valid	93.33
4.	Module contains reading activity related to green marketing and digital marketing.	4.67	Very valid	93.33
5.	Module contains decision-making or problem-solving activities.	4.67	Very valid	93.33
6.	Module contains problems that help students improve entrepreneurial skills.	4.67	Very valid	93.33
7.	Activities in the module are the application of concepts of green marketing and digital marketing concept.	4.33	Very valid	86.67
8.	Module can trigger students' curiosity.	4.67	Very valid	93.33
9.	Module can promote collaborative skills.	4.67	Very valid	93.33
10.	Module can promote communication skills.	4.33	Very valid	86.67
11.	Module can promote critical thinking skills.	5	Very valid	100.00
II. Construction				
1.	Module applies an entrepreneurship education.	4.67	Very valid	93.33
2.	Instructions in module is clear and do not make misunderstanding.	4.67	Very valid	93.33
3.	The breakdown of material content (Organizational structure/ order of content)	5	Very valid	100.00
4.	Accuracy module summary as material repetition	4.33	Very valid	86.67
III. Understanding				
1.	The information in module is easy to understand by students	4.33	Very valid	86.67
2.	The language used in module is in the same manner with General Guidelines for Indonesian Spelling (PUEBI).	5	Very valid	100.00

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The teaching materials is also in accordance with the learning goals of Entrepreneur Theme of Community Service Program. The teaching material can guide students to think more about their project for green digital marketing issues. Mentorship activities involving both supervisors and the owner of SME Daun Efek as local entrepreneur facilitate students to learn more about the situation before determine their marketing strategy for their project. This type of training offers students a chance to get clearly knowledge of what an entrepreneur is, as well as to be introduced as future entrepreneur into local business environment [15].

Furthermore, the module contains project activities to make a decision and solve the problems faced by local entrepreneur and try out the solution during Community Service Program. These activities aim to utilize students' problem-solving skills and train them to think out of the box by being innovative to design and execute their project. However, students will need more guidance both from professional lecturers of entrepreneurship education and experienced entrepreneurs [16].

Time allocation is also a factor that must be considered during the project [16]. Project-based learning is not a method that can be implemented in a short time. In Project Based Learning, students must organize their projects and manage time they need [17]. In developing the project design, there are several activities that must be undertaken by students, such as making a division group, formulating regulation, planning activities, monitoring, and formulating assessment [17]. Supervisors of Community Service Program have to design the students' schedule from the beginning to the end of the program. Thus, students' project can be done by the end of the program.

During the project, students will work in group. Thus, it will improve their communication and collaborative skills. The project will improve their teamwork and personal development and character [17]. The interaction among group will give them an opportunity to promote communication and critical thinking [18,19]. Discussion sessions can increase students' self-confidence, communication skills, and prompt students' learning because students become more active and involved in learning and the learning material [20].

It is also suggested to provide module with various media that can be accessed by students. The module can provide link to lead students to find more information about green marketing and digital marketing on the internet. It can make module more interesting and promote student attractiveness to learn about the subject [21].

Based on Table 3, the module can be used with little revision. Some suggestions from validators are used to revise the module. The module will be implemented after the revision.

Conclusion

The results showed that the module has been developed was feasible to be used in entrepreneurship classes for science preservice teachers. It can be concluded that this module can be applied for Community Service Program to promote entrepreneurial skills of science pre-service teachers. However, the further study on how effective the module to utilize entrepreneurship skills of science pre-service teachers must be done later for more information.

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Project-based entrepreneurs learning model's efficacy and effectiveness on students at the State University of Medan

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Abstract. *This study set out to evaluate the Project-Based Entrepreneurship Learning Model's efficacy and efficiency. This study employs research and development techniques (Borg and Gall, 1983). The outcomes demonstrated the effectiveness and efficiency of the entrepreneurial learning approach. It is known that the average value is 3.67. This average value, can be said that the project-based model's a legitimate degree of validation. The average score on the aspect of module 3.68, and the average score on the element of module completion is 3.70. The entrepreneurship learning module's validation overall average of 3.69. For validation level, this average value is legimate. The fact that the level of student mastery is high suggests this. This indicates that 80% of 249 the students have a solid understanding of the course subject. These results indicate that every student received a score above 80. It is common knowledge that students may complete questions more quickly than the 75 minutes allotted for preparation. As many as 32 students can take the test in 50–52 minutes, 26 in 53–55 minutes, 23 in 56–58 minutes, 31 in 59–61 minutes, 8 in 62–64 minutes, 99 in 65–67 minutes, and 30 in 68–70 minutes, all from the minimal standard time allotted to work on the questions. Given that students can work for less time than is necessary, the data demonstrates the effectiveness of the Problem-Based Entrepreneurship Learning Model.*

Keywords: learning model,eEntrepreneurship, project-based learning

Introduction

The entrepreneurship education program that has been established at colleges has not been completely utilized. In particular, in the entrepreneurship practice course, students merely create business plans, and occasionally, they do not put such plans into effect. Under these circumstances, lecturers must be able to fully create entrepreneurship learning frameworks. Universities have several alternatives for fostering student creativity, one of which is incorporating it into the core curriculum or offering courses that complement it.

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All students at State University of Medan are required to take the Entrepreneurship Course, regardless of their faculty. An entrepreneurial proposal that is materialized as a student's small business is the course's end result. Student business forms have been implemented so far, but not to their full potential. According to the findings of a study [1], entrepreneurial interest at State University of Medan is still quite low and students there are not yet ready to develop a strong entrepreneurial spirit. This study examines how the university promotes the development of young entrepreneurs using project-based entrepreneurial learning models that are based on the material covered in the classroom. The effectiveness and efficiency of the entrepreneurship learning model used by students at State University of Medan will also be evaluated in this study. The formulation of the research problem is as follows, based on the backdrop of the topic mentioned above: 1) How is the State University of Medan student project used to inform the entrepreneurship learning model? 2) Is the Entrepreneurship Learning Model Based on the Student Project at State University of Medan Effectively Implemented? 3) Do Entrepreneurship Lectures Follow an Effective Model of Learning Based on Student Projects at State University of Medan?

Methodology

The Project-Based Learning Model (MPBP) is a method of learning that entails concentrating on significant questions and problems, problem solving, decision-making, the process of looking up various sources, providing opportunities for participants to work collaboratively, and concluding with presentations of actual products [2]. This project-based learning not only examines the relationship between theoretical and practical information, but also encourages students to reflect on what they have learned while working on a real project. Students can work in real, as if they existed in the real world, and can produce realistic products [3]. The basic idea is that most learning processes that take place during this complex activity are disorganized. Additionally, project-based learning can boost students' self-esteem, ambition to learn, creativity, and self-worth [4]. Steps for project-based learning, Identifying the fundamental inquiries [5]. Essential questions, i.e. ones that can provide students assignments for completing an activity, are where learning starts. Making project plans is step two. Teachers and students work together to plan; step three is to set up timetables. In order to complete projects, teachers and students collaborate to set up activity plans. (4) Track students' and projects' advancement. The teacher is in charge of keeping an eye on the students' project-related activities. By assisting students in each procedure, monitoring is accomplished. A rubric is made that can record all significant activities in order to streamline the monitoring process. 5. Verify the outcomes. The assessment is done to help teachers gauge how well standards are being met, to evaluate each student's development, to give feedback on the degree of comprehension that students have attained, and to help teachers come up with the next learning plan. 6) Consider your experience. The teacher and students discuss the exercises and project outcomes at the conclusion of the lesson. The process of reflection is done both privately and in public.

Product development model [6] is integrated with learning development model to create a project-based learning paradigm for entrepreneurship courses [7]. The actions researchers should take to ensure the goods they design meet a feasibility standard are outlined in the Borg and Gall development model.

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Syntax of learning model

The provided learning model has the following syntax:

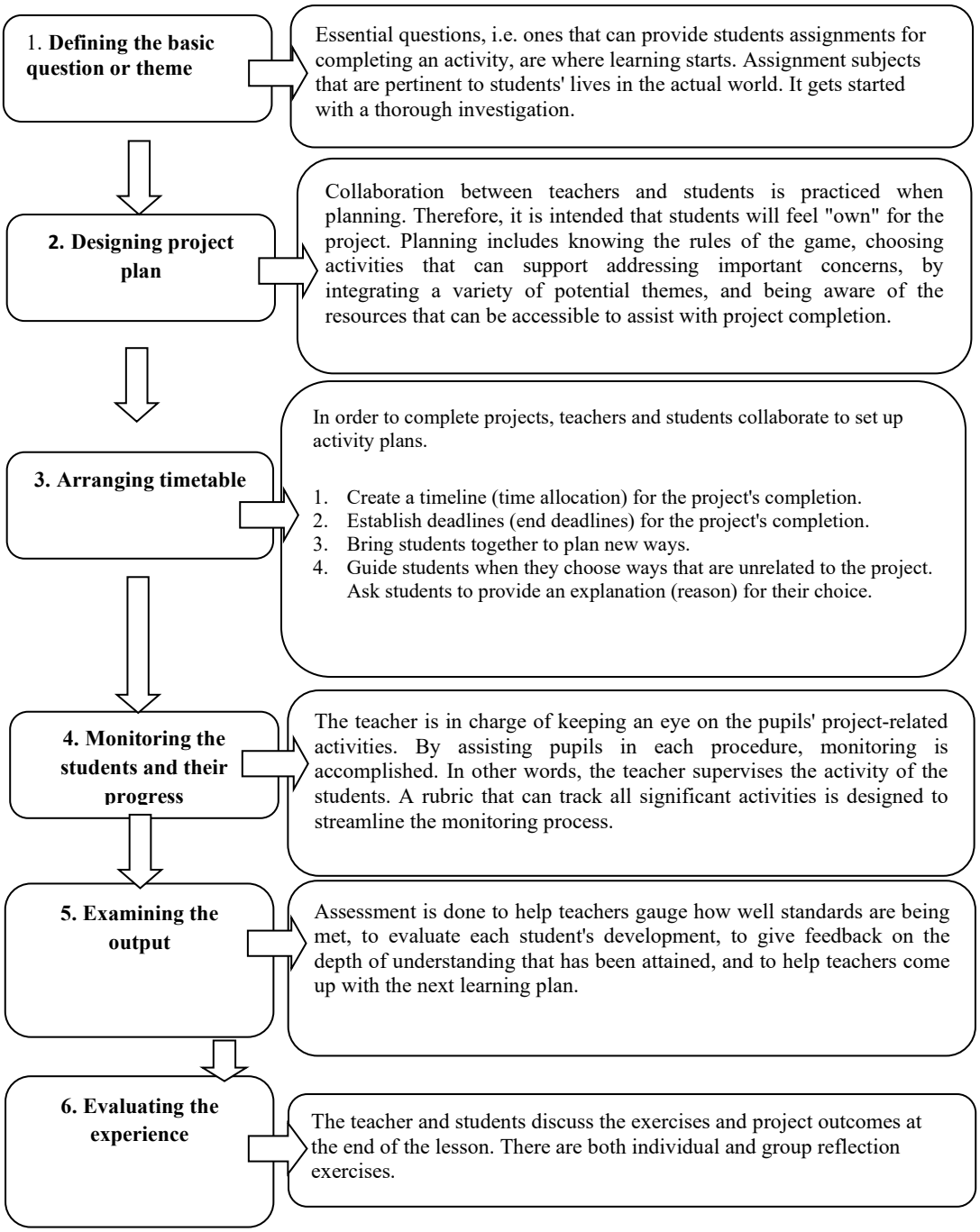


Figure 1. Illustration of learning syntax based on project from entrepreneurship course

Studying learning innovations with a chain impact is required to support the attainment of the goals of the Entrepreneurship quality improvement program. For instance, the project learning approach is used in entrepreneurship courses and is packaged in a way that is connected

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with the IQF-based curriculum that Unimed currently uses. Numerous research findings indicate that there is still a dearth of faith in both our students' and the public's enthusiasm in entrepreneurship. In her study on the effectiveness of implementing programs to develop entrepreneurship in micro, small, and medium-sized businesses [8]. In her study on the effectiveness of self-potential development and entrepreneurial orientation in enhancing entrepreneurial attitudes, students' levels of self-esteem tend to be lower than students' levels of achievement, innovation, personal control, and self-esteem. entrepreneurship-related attitude-building dimensions [9].

Students' efforts to develop intricate and experienced memory representations, which demonstrate a strong level of connectivity between semantic, episodic, and action knowledge, can be facilitated by learning that takes place in project-based learning models [10]. Students in project-based learning also apply fundamental skills to aspects of scientific performance, such as planning and design, use of equipment (if the produced product is an innovative product), implementation, observation and recording, interpretation, and responsibility, in their specific action to produce a product. Therefore, this project-based learning approach has a great deal of potential to enhance learning. In her thesis on the impact of project-based learning models on students' capacities for creative thought and scientific performance [11]. Demonstrated that groups of students who learn to use project-based learning models have stronger capacities for creative thought than groups of students who learn to use conventional learning models. According to studies employing project-based learning models [12] groups of students studying with a traditional learning method and students studying with project-based learning models have significantly different capacities for creative thinking (MPBP). Based on the aforementioned research findings, it can be assumed that the development of a project-based entrepreneurship learning model and its integration with the IQF curriculum currently used at Unimed can improve the entrepreneurship learning outcomes of Unimed students, or, to put it another way, can increase student interest in entrepreneurship.

Learning model for project-based entrepreneurship: effectiveness and efficiency

Effectiveness, as a whole, is a state that demonstrates the degree of accomplishment or achievement of a goal as assessed by quality, quantity, and time as originally anticipated. Effective learning, according to [13], is a structured combination of human, material, facilities, equipment, and procedures intended to change students' behavior in a positive and better direction in accordance with each student's potential and differences in order to achieve the learning objectives that have been set. The following traits define an effective and efficient learning process through learning: 1) Learner-centered; 2) educating interaction between teachers and students; 3) employing a variety of teaching techniques; and 4) providing supportive learning environments. While efficiency is judged by the amount of components utilized to obtain the desired results, effectiveness is actually established by assessing the degree to which the learning process realizes the desired objectives. Efficiency is a term that describes the ideal balance between effort and output. An effective learning method is accelerated learning. Efficiency is a notion that captures the ideal balance between effort and outcome [14].

The following criteria will be used to evaluate the effectiveness and efficiency of the entrepreneurship learning model based on the Unimed student project:

1. The effectiveness of entrepreneurship learning in piqueing students' interest in entrepreneurship through projects that will be carried out utilizing questionnaires will be

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evaluated based on how the learning model appears, the steps (syntax), and the process carried out in that learning.
2. The degree of student satisfaction and the pace of project-based entrepreneurial learning model implementation will be used to measure efficiency.

Methodology

This research also looks at development (Developmental Research). A project-based entrepreneurial learning paradigm for students at State University of Medan is the end result of this research. Additionally, this study intends to evaluate the performance of the developed project-based entrepreneurial learning paradigm. The participants in this study are State University of Medan students who took entrepreneurship courses in 2022. This research, which strives to raise educational standards, is also known as "research-based development." This development research is used to create an entrepreneurial learning model that can boost the creativity of Unimed students in addition to creating and validating educational outcomes. Educational research and development (R & D) is a process used to generate and validate educational production. According to this quotation, research and development are carried out in cycles, with each phase referring to the previous results in order to build a new program. "Research and information gathering, planning, developing preliminary form of product, preliminary field testing, main product revision, main field testing, operational product revision, operational field testing, final product revision, and dissemination and implementation" are the steps outlined as necessary for this approach. The Learning Outcomes Test and Observation Techniques, Interviews, and Questionnaires were used to collect information on the Quality of Learning and the Implementation of Learning from the Entrepreneurship Course. A learning outcome exam was utilized to gather information regarding learning outcomes. Interviews, observation logs, and questionnaires were utilized to gather information about the application of learning [15].

The RPS and the Module developed for entrepreneurship learning are suitable for use for entrepreneurship learning, according to statistics based on the validator's assessment. Validation of the project-based entrepreneurial learning model's implementation plan for learning in terms of the evaluation aspects: (1) The clarity of the formulation of core competencies and basic competencies, the sufficiency and completeness of the indicator formulation, and the appropriateness of indicators with basic competencies make up the competencies and indicators formulation. (2) The organization of learning materials comprises of the teaching materials' suitability for core skills, the materials' coherence and systematic arrangement, the materials' suitability for the characteristics of the students, and the materials' suitability for the time allotted, (3) The application of learning syntax, the provision of learning stages to achieve competence, the opportunity for students to gain concrete, meaningful experiences, the encouragement of students to participate in activities and problem-solving activities, the encouragement of students to discuss and reflect, and the application of learning strategies in accordance with the characteristics of students are among the learning strategies/methods. (4) The selection of learning resources and media includes the appropriateness of learning resources and media, the appropriateness of learning media with learning materials, the appropriateness of learning resources and media with student characteristics, and (5) evaluation of learning outcomes includes the clarity of assessment processes, suitability of the type and form of evaluation with competence, and suitability of the question items with indicators.

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The expert's evaluation of the learning implementation plan's validity produced the following results:

Table 1. Expert validation on learning implementation plans

No	Items	Validators			Average Score
		1	2	3	
1	Formulation of Competencies and Indicators	3,66	3,66	3,66	3,66
2	Organizing Learning Materials	3,50	3,75	3,75	3,66
3	Learning Strategies/Methods	3,57	3,71	3,71	3,66
4	Selection of Educational Resources and Media	3,66	3,66	3,83	3,71
5	Evaluation of Learning Outcomes	3,66	3,66	3,66	3,66
					3,67

According to the information in the table above, the average value for the indicator competency formulation aspect is 3.66, the average value for organizing learning materials is 3.66, the average value for strategy/learning method is 3.66, and the average score is 3.66. the average value in the evaluation of learning outcomes is 3.66, while the average value in the aspect of choosing learning materials and learning media is 3.71. It is known that the average value for the validation assessment of the implementation plan for the project-based entrepreneurial learning model is 3.67. According to the previously stated criteria for establishing the validation level, the level of Validate the implementation of the project-based entrepreneurial learning model learning implementation plan valid category is indicated by the average value of 3.67**.**

Validation of the project-based entrepreneurship learning module in the assessment areas: (1) module cover, module presentation design, printouts, font shape, and font size; and (2) module completeness, which includes an introduction and table of contents, information on modules, instructions for using modules, graduate competency standards, core competencies, basic competencies, and indicators of competency achievement. The findings of the experts' module validation evaluation are as follows:

Table 2. Module validation table by experts

No	Items	Validators			Average scores
		1	2	3	
1	Module Display	3,8	3,63	3,60	3,68
2	Module Equipment	3,72	3,63	3,72	3,7
					3,69

The average value for the module display aspect is 3.68, and the average value for the module completeness aspect is 3.70, according to the data in the table above. It is clear that the average value for the validation assessment of the project-based learning module is 3.69 based on the average value for each element. The level of validation of the project-based entrepreneurship learning module is a legitimate category, as indicated by the average value of 3.69 when compared to the criteria for defining the level of validation that have already been established.

The data on learning outcomes acquired demonstrate the effectiveness and efficiency of the entrepreneurship learning paradigm. The fact that the level of pupil mastery is high suggests this. This indicates that 80% of the students have a solid understanding of the course subject. Of the 249 pupils, 59 had grades above 80-82, 64 between 83 and 85, 34 between 86 and 88, 69

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between 89 and 91, and 23 between 92 and 95. These results indicate that every student received a score above 80.

Table 3. Frequency distribution of student learning outcomes

Class	Interval	Frequency
1	80-82	59
2	83-85	64
3	86-88	34
4	89-91	69
5	92-95	23

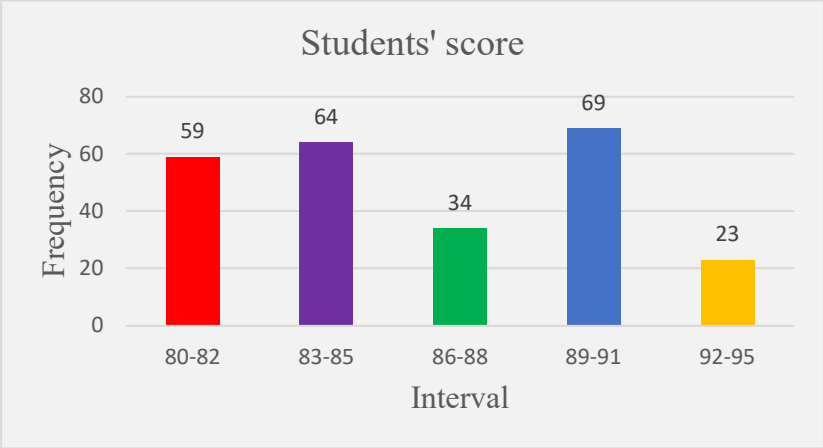


Figure 2. Frequency distribution of student learning outcomes

It is known from efficiency that students can complete the questions more quickly than the allotted 75 minutes. As many as 32 students can take the test in 50–52 minutes, 26 in 53–55 minutes, 23 in 56–58 minutes, 31 in 59–61 minutes, 8 in 62–64 minutes, 99 in 65–67 minutes, and 30 in 68–70 minutes, all from the minimal standard time allotted to work on the questions. Given that students can work for less time than is necessary, the data demonstrates the effectiveness of the Problem-Based Entrepreneurship Learning Model.

Table 4. Data on the results of student responses to the application of components and learning activities

Class	Interval	Frequency
1	50-52	32
2	53-55	26
3	56-58	23
4	59-61	31
5	62-64	8
6	65-67	99
7	68-70	30

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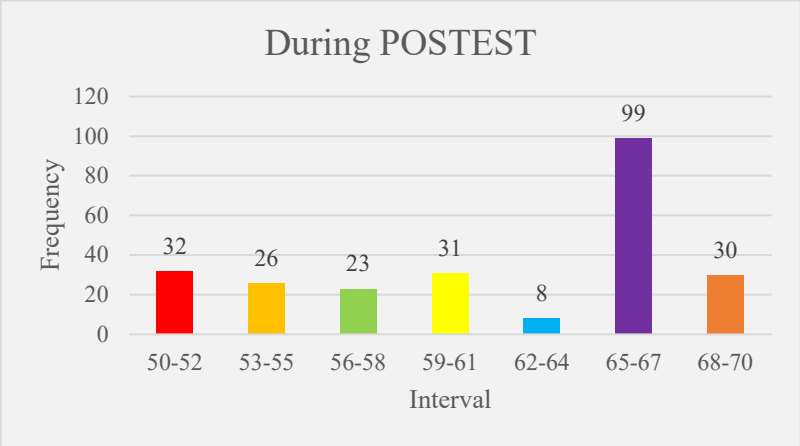


Figure 3. Frequency distribution of student learning outcomes after postest

Conclusion

From the results of the research conducted, the discussion of the research and the results of the research, the following matters were obtained:

1. The Unimed Entrepreneurship Learning Model is effectively used in Entrepreneurship learning
2. The Unimed Entrepreneurship Learning Model is efficiently used in Entrepreneurship learning.

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Pre-service science teachers' perception toward STEM education

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Abstract. *STEM education is deemed a promising approach to developing students' competencies for surviving in the global environment. This learning approach has been implemented in many schools and universities in Indonesia. However, limited studies in Indonesia have focused on the perception of this topic. Therefore, this study aimed to describe pre-service science teachers' perception of STEM education. This descriptive study adopted a valid questionnaire to collect relevant quantitative and qualitative information from 52 pre-service science teachers at the Faculty of Mathematics and Natural Sciences at a university in Surabaya, Indonesia. Descriptive statistics including means and percentages were calculated to analyze the collected quantitative data, whereas the content analysis method was adopted to analyze qualitative information. The research findings indicated that the pre-service science teachers had positive perceptions of STEM education and understood the importance of this learning approach. However, most of them had insufficient understanding of STEM applications, especially for environmental protection issues. Implications of this study are discussed.*

Keywords: microlearning, research skills, learning method, mathematics education

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Introduction

The notion of Science, Technology, Engineering, and Mathematics (STEM) has gained popularity in recent years, especially in education fields [1-3]. STEM education is deemed a promising approach for developing students skills that are critical for the 21st century, including communication and collaboration [4], critical thinking [5], creative thinking [6], and problem-solving skills [7]. It is possible because interdisciplinary aspects of STEM education in real contexts require students to use a variety of thinking, problem-solving, and communication skills [8, 9]. STEM education also focuses on designing and manufacturing products or systems using the principles of inquiry and exploration [10]. Therefore, STEM education encourages students to develop creativity, innovation, problem-solving, and collaboration. Furthermore, the integration of two or more STEM domains through practical activities in authentic contexts in STEM learning enables students to enhance their understanding of the concepts being learned [10-12]. The interaction with STEM practices also improves students' interest in STEM-related professions [13, 14].

The advantages of STEM education have attracted the attention of researchers and education practitioners in Indonesia. There were 27 papers that discussed the implementation of STEM education in Indonesia from 2015 to 2020 [15]. The Indonesian government through educational institutions and organizations is also aggressively conducting the socialization of STEM education [16]. As a result, STEM education is implemented in elementary [17, 18], secondary [13, 19], senior high [7, 20] schools, and tertiary education [12]. STEM education is applied through the implementation of learning models for a particular subject, such as project-based learning, 6E, inquiry learning, cooperative learning, and problem-based learning [15, 16]. While other schools create STEM subjects as local content or integrate relevant subjects at the school level under STEM-based projects [16]. Differences in STEM implementation are influenced by the principal's commitments, school facilities, student characteristics, and colleague support [16].

In fact, the implementation of STEM education in Indonesia is unequal. Although many teachers understand the importance of STEM, many of them do not apply STEM in their school or classroom, resulting in many students being unfamiliar with the notion of STEM [21]. Many teachers also have difficulty implementing STEM in their teaching and learning activities [22]. Some of them have different views regarding STEM education, thus, the strategy they selected to integrate STEM into the curriculum is also different [22]. These conditions indicate the low STEM literacy in Indonesia [23].

Preparing pre-service teachers through teacher education programs is considered as a potential solution for the aforementioned problems [24, 25]. The well-designed STEM learning that pre-service teachers experienced during their study affects their knowledge and teaching practices in their future professional life [25]. Therefore, assessing pre-service teachers' perception toward STEM education is crucial to understand the extent of their STEM literacy [26]. However, the research on pre-service science teachers' perceptions of STEM education is limited, especially in the context of science education [15, 27] where STEM learning commonly takes place. Therefore, the current study aimed to investigate how pre-service science teachers perceived STEM education by focusing on STEM literacy categories.

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Methodology

The current study adopted descriptive research because it aimed to describe and interpret 52 pre-service science teachers' perceptions toward STEM education [28]. The pre-service teachers were students who enrolled in one of four undergraduate study programs under the Faculty of Mathematics and Natural Sciences, including Physics Education, Chemistry Education, Biology Education, and Science Education at a university in Surabaya, Indonesia. During the research, these participating students were in the second year of study and have taken the same courses, including Basic Mathematics, Basic Physics, Basic Chemistry, Basic Biology, and Digital Literacy. These courses represented STEM components but they were taught in isolation.

The current study gathered intended information to gain insights into pre-service teachers' perceptions of integrated STEM by adapting a valid and reliable questionnaire developed by Chamrat et al. [29]. The questionnaire covers five categories of STEM literacy (integrated STEM), including STEM concept, STEM practice, STEM application, STEM attitude, and STEM-related context. The Item Objective Congruence (IOC) index of the questionnaire ranges from 0.67 to 1, and the value of Cronbach's Alpha Reliability is 0.97, meaning that all items have acceptable content validity and excellent internal consistency, respectively. The questionnaire used in this study consisted of 34 items in total, including three short-answered questions about students' identity, 30 items asking students' perception of integrated STEM, and one open-ended item requiring students to give an example of the implementation of STEM for environment protection. Each item about integrated STEM perceptions was accompanied by a five-point scale ranging from 1 to 5 (do not know, strongly disagree, disagree, agree, and strongly agree). The questionnaire was created using a Google Form and administered to students at the fifth meeting. The use of an internet-based survey is beneficial for rapid distribution and data entry [28].

The collected quantitative data were calculated using descriptive statistics, including means and percentages for describing and interpreting pre-service teachers' perception of integrated STEM. Microsoft Excel was utilized for the calculation purpose. In addition, a one-way ANOVA (Analysis of Variance) with post-hoc Tukey HSD (Honestly Significant Difference) test was conducted using an online calculator provided in https://astatsa.com/ for analyzing the significant difference of perceptions among the four study programs. While students' responses on the last open-ended item were analyzed using the content analysis method. The method included coding, categorizing similar responses, comparing categories, and concluding [28, 30]. For this purpose, Voyant Tools online application was used to assist the coding and categorizing processes.

Results and discussions

Results

This study collected quantitative and qualitative data for describing pre-service teachers' perceptions of STEM education. Results of data analysis are presented in this section in different sub-heading for easy reading. The quantitative data are described first followed by the interpretation of qualitative information. The presented data are then discussed further in the Discussion section.

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Pre-service science teachers' responses on the questionnaire

To understand perceptions of STEM education, responses of pre-service teachers from the four study programs on the 30 five-point scale items were tabulated and analyzed. The percentages of the responses on each STEM literacy category in the questionnaire is shown in Figure 1.

Figure 1 shows that most participating pre-service science teachers have a good perception of STEM education. More than 70% of Agree responses are recorded for the items in the five categories of STEM literacy. More than 10% of Strongly Agree responses are also captured for similar categories. STEM attitude receives the highest percentage of positive responses (91.71%) from the respondents indicating that the pre-service science teachers understand the importance of STEM education. In contrast, the lowest percentage of positive responses (86.66%) is found in the STEM application category, meaning that the pre-service science teachers need to interact with more activities that require STEM applications.

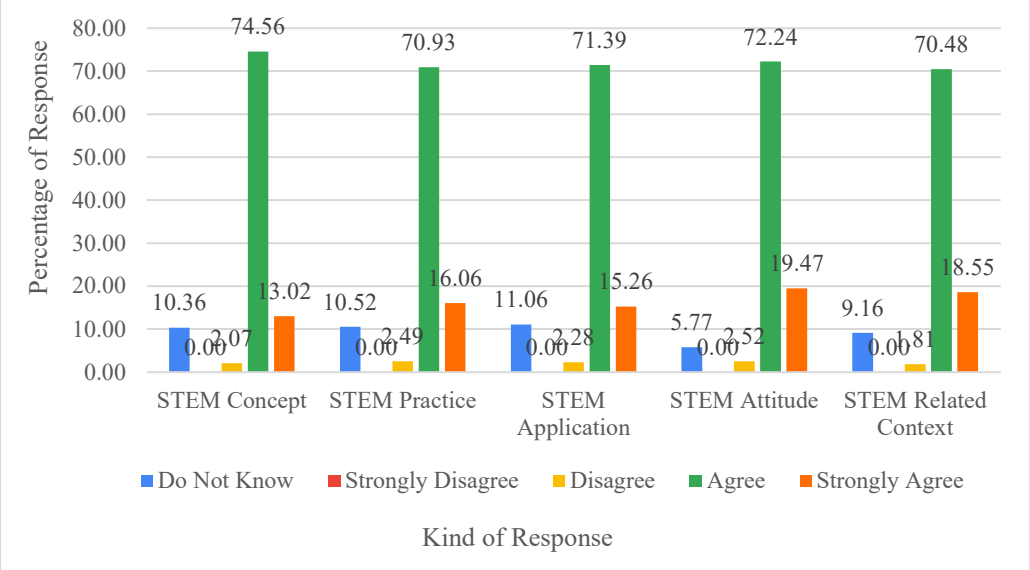


Figure 1. Pre-service teachers' responses by study program

However, Figure 1 also exhibits pre-service teachers' lack of knowledge and understanding of STEM education. Ranging from 5 to 11 % of Do Not Know responses are presented in the five categories of STEM literacy. STEM application and STEM attitude are recognized as the categories with the highest and lowest percentages of Do Not Know responses, respectively. Both the facts are in line with the results that reveal in the preceding paragraph that these categories received the lowest and highest percentages of positive responses. In addition, the Disagree responses are apparent in each category of STEM literacy ranging from 1% to 2%. These findings indicate few of the pre-service science teachers were illiterate in STEM education.

Pre-service science teachers' responses by study program

The questionnaire used in this study was administered to pre-service teachers from four study programs, including Undergraduate Program in Physics Education, Chemistry Education, Biology

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Education, and Science Education. The number of respondents for each study program was 14, 17, 14, and 7 pre-service teachers, respectively. The mean of the respondents' responses in each study program is presented in Figure 2.

Figure 2 shows that the pre-service teachers of Chemistry Education and Science Education have the highest and lowest means of perceptions toward STEM education, respectively. These findings indicate that pre-service teachers from both study programs have different levels of STEM literacy. The result of one-way ANOVA also suggests that there are significantly different perceptions of STEM education between two or more study programs. Furthermore, the Tukey HSD test result indicates that significantly different perceptions of STEM education occur only between pre-service teachers of Chemistry Education and Science Education, thus, confirming the data in Figure 2.

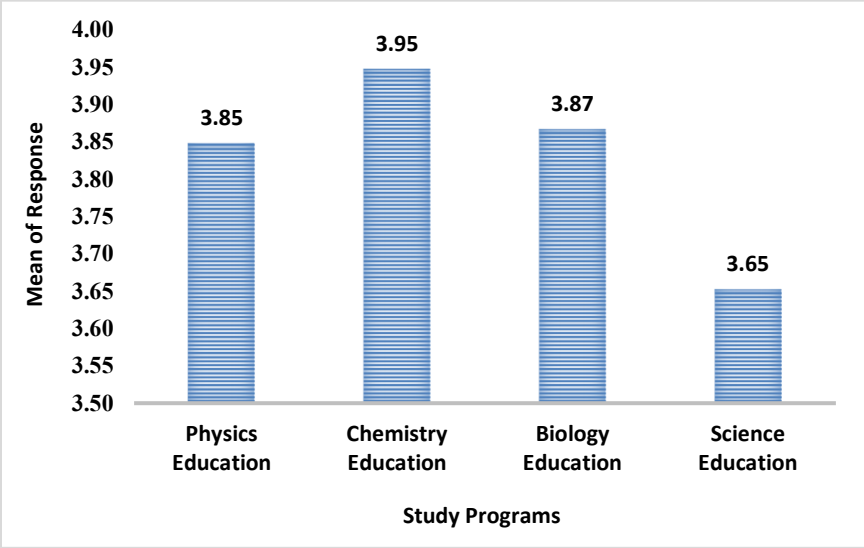


Figure 2. The mean of pre-service teachers' responses in each study program

However, this finding needs to be confirmed by other large-scale studies. Basically, the nature of the four study programs is similar, but the emphasis of each of them may be diverse, leading to differences in learning experiences.

Pre-service science teachers' examples of STEM application

In addition to quantitative data, the questionnaire utilized in the current study collected qualitative information from pre-service teachers through an open-ended item. This item asked pre-service teachers to give one example of a STEM application for environmental protection. The data, then, was analyzed in terms of content. The result of the content analysis is visualized in Figure 3.

In figure 3, it is apparent that the most mentioned words by pre-service science teachers when talking about a STEM application for environmental protection are "Waste"; "Environmental"; and "Technology". When focusing on waste, the pre-service teachers tended to talk about waste management or waste processing approaches, such as recycling. Pre-service teachers who emphasize environmental aspects discussed environmental problems and

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conservation using STEM applications. Most of the pre-service teachers focused on the use of technology and connected this aspect with engineering and mathematics.

Furthermore, the results of careful analysis of pre-service teachers' responses indicate that these respondents have an insufficient understanding of STEM applications for environmental protection. Most of them wrote their ideas without making an explicit connection to STEM aspects. Examples of the fact are when the respondents mentioned "construction of concrete embankments on the beach to avoid abrasion" and "construction of hydroelectric power plants in shortage areas". Both ideas are relevant to STEM application, but the connection of these ideas to STEM components is missing. In contrast, another respondent mentioned the STEM components, but the idea of STEM application was unclear. It is apparent when the respondent wrote "by designing a tool or technology that is guided by scientific principles so that it can overcome waste problems, especially plastics or polymers". Surprisingly, the other respondents mentioned unrelated ideas, such as "Throw garbage in its place", "Determine the cost of goods and selling prices in the market", and "Observing fruit plantations".

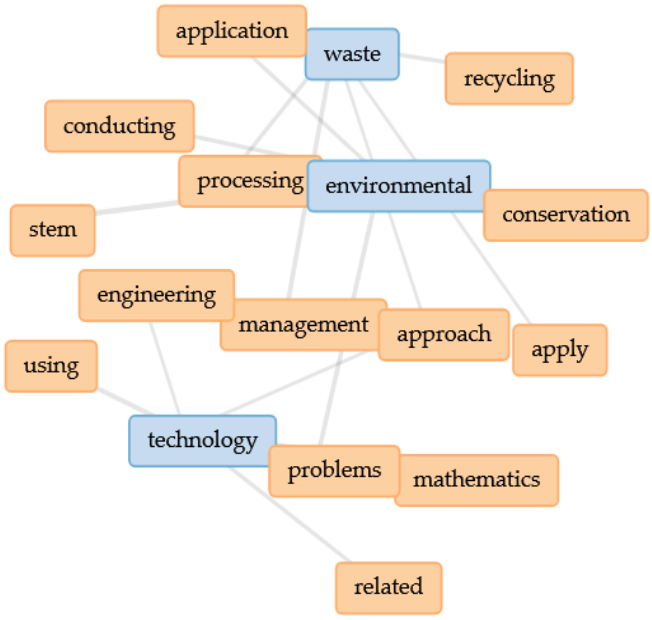


Figure 3. Network visualization of pre-service teachers' ideas about a STEM application for environmental protection

However, few of the respondents wrote exemplary examples of STEM applications for protecting the environment. An instance of this fact is presented in the following sentence.

"*Factory chimney filtration* applies STEM to conserve the environment for better air quality. In the field of *science*, this activity is certainly related to filtration using *permeable membranes*…The application of *technology* is setting the *filtration device automatically*…it is also related to the field of *physics* which applies the *principle of hydrostatic pressure*…in the *mathematical concept* of *calculating the amount of smoke volume intensity* that is processed every day so that *an evaluation* can be carried out…*adding new production equipment* that does

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not produce smoke…if less pollution occurs, it can also save costs for residents around the factory as well as for more efficient and cost-effective waste treatment."

The statement written by the respondents comprehensively described the STEM-related idea of protecting the environment. The STEM components including Science, Technology, Engineering, and Mathematics are explained in detail in the sentence (see the italic words). This fact indicates the respondent's sufficient understanding of STEM. However, this phenomenon is found limited in the current study suggesting that most of the participating pre-service science teachers need to be involved in STEM-related training and professional development programs.

Discussions

The results of the current study reveal that most of the participating pre-service science teachers have good perceptions of STEM education in terms of the five categories of STEM literacy, including STEM concept, STEM practice, STEM application, STEM attitude, and STEM-related context. The high percentages of positive responses (Agree and Strongly Agree) for STEM attitude indicate that pre-service science teachers understood the importance of STEM education for daily and professional life, problem-solving activities, the environment, and the economy. A similar finding is also observed in the previous studies [25, 31, 32]. These studies found that pre-service teachers are interested in STEM education and found that the approach contributes to learning. The pre-service teachers' interest and attitude toward STEM education need to be maintained through intensive exposure to STEM practices using authentic contexts [25]. According to Schunk [33], attitude is an internal belief that influences behavior. Thus, interest and attitude are prerequisite factors to make pre-service teachers actively engage in STEM learning [14].

In contrast, the pre-service science teachers gave the lowest positive responses for the STEM application category. The finding is also confirmed by the results of qualitative information indicating that the pre-service science teachers had insufficient knowledge and understanding of STEM applications, especially for environmental protection. Pre-service teachers' difficulties in applying STEM education were also observed in several studies [26, 31, 32]. Indriyanti, et al. [31], for example, revealed that most pre-service teachers from Chemistry Education only understand the general definition of STEM, but they find it difficult to make connections among STEM components. This phenomenon was also observed in the current study. Pre-service teachers' lack of knowledge and understanding of STEM education affects their teaching practices [31]. Several challenges that pre-service teachers face when preparing for STEM learning include selecting the appropriate topic and project, time management, designing learning media, and lack of instructional time [26, 31]. Those problems are classified as intrinsic barriers because they come from the personnel of the pre-service teacher [34].

The current study found significantly different perceptions of STEM Education between pre-service teachers from Chemistry Education and Science Education. Pre-service teachers from Science Education tended to have lower perceptions of STEM education compared to their counterparts. While Chemistry Education emphasizes chemistry topics, pre-service teachers from Science Education learned physics, chemistry, and biology subjects. Based on this fact, pre-service teachers from Science Education should experience more STEM practice exposure than their counterparts from Chemistry Education. This contrary finding needs to be confirmed by large-scale studies. A similar study conducted by Indriyanti, et al. [31] which involved pre-service teachers from Chemistry Education, in fact, reported identical findings to the current study. It

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means that the pre-service teachers' perceptions of STEM education are not largely affected by the nature of the study program, but by the experience of STEM learning, practices, or projects [25].

Conclusion

The current study investigated perceptions toward STEM education of pre-service teachers from the four study programs, including Physics Education, Chemistry Education, Biology Education, and Science Education. The findings of this study indicated that most pre-service science teachers have good perceptions of STEM education in terms of STEM literacy categories, including STEM concept, STEM practice, STEM application, STEM attitude, and STEM-related context. The STEM attitude category received the highest percentages of positive responses meaning that most pre-service science teachers understood the essential of STEM education for real life, professional, environmental and economic aspects. In contrast, the percentage of pre-service teachers' perceptions of the STEM application category is the lowest, indicating their lack of knowledge and understanding of STEM education. The results of the current study confirmed the findings of previous research.

Ba sed on the findings of the current study, it is suggested that the pre-service teachers from the four study programs need to be exposed to more well-designed STEM learning experiences. Workshops and professional development programs about STEM can be also provided to develop pre-service science teachers' skills in designing and preparing STEM learning. Berisha and Vula [25], furthermore, observed that collaboration, effective learning environments, and participatory practices are crucial aspects in learning activities, workshops, or professional development programs for improving pre-service teachers' conceptualization of STEM. Using these efforts, pre-service science teachers are expected to have sufficient STEM literacy, thus, supporting the sustainability of STEM in Indonesia.

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