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APPLICATION OF COGNITIVE THEORY OF CONTENT ON LEARNING ABILITY TO INCREASE PHYSICAL SCIENCE USING GENERIC INJECTION NEEDLE KIT

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ABSTRACT

The background of this study of physics learning problems that students are less active during this time. Monotonous learning methods that teachers only make the students as recipients of information, so that students are not accustomed to using the generic skills in the science classroom. Learning physics is still theoretical and less able to develop generic skills of students, thus affecting the quality of learning is less efficient teachers. Then applied learning theory of cognitive load through props syringe as waste. The purpose of this research is to improve students' ability to apply the generic cognitive load theory. The results showed that the achievement of developed Generic Capability is Capability Direct Observation (MPA) reached 82.05%, Mathematical Modelling Capability (KPM) reached 74.24%, Ability Logic Inference (Kil) is 72.57%, Capability Building Concept (KMKs) reached 61.03%. Achievement of the learning effect of cognitive load theory that arises is contained 5 effects. The fifth effect is the effect of the 2nd, which is "not given a grain sample completion, the new concept" of 33.33%, the effect that the 3rd is "a dish that makes the division of attention," amounting to 66.67%, the effect is the 5th "Serving excessive" reaches 33.33%, 8 to the effect of "Do not be guided or instructed, the new concept of" reached 33.33% and the effect of the 9th "Too much coaching or guidance for the old concept of" reached 66.67%. The emergence of the cognitive effects indicate the maximum lack of teachers apply learning theory of cognitive load while the student is still a recipient of information that are active in the learning process. It is necessary to study the cognitive load theory re-use to maximize the learning stages of cognitive load theory that the results are expected to improve the ability of generic science can be maximized and the resulting physics learning more efficient.

***Keywords**: Cognitive Load, Generic Capabilities Science*

INTRODUCTION

The curriculum is prepared not only to improve students' cognitive intelligence is also aimed at improving the skills of the students. These skills are needed when students live independently and participate in education to a higher level. So also in the learning of physics at the high school level, in addition to aiming to build knowledge of concepts, learn physics basically also have to involve students actively in the learning process to build the basic skills of science students and scientific work in order to produce a product of science.

The ability of students to work scientifically created to develop generic skills learning science in physics. Development of generic skills is very important science is owned by the students because these skills can be applied in real life students to face the era of technological

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and scientific advances. In addition, the ability of generic science students can also be applied to achieve student learning and success in the real world.

Experience teaches physics teacher during class less develop science skills of students. Learning physics is still applied only to measure the students' cognitive abilities alone, studying physics still require students to memorize about the concept and theory, and practice doing arithmetic operations. Learning physics still refer to the textbook of the students without adjusting the characteristics and competencies of its learners. As a result of the implementation of learning as described above, is the lack of development of students' ability innovative thinking patterns, creative with the mindset of a high level and low ability to cooperate with others.

When teachers carry out an evaluation at the end of the learning of the students only measure of a student's cognitive ability test results without measuring the performance capabilities of students. When implemented physics lab while correcting the results of the report, often found a report that the students are not able to interpret the experimental data. The ability to deliver a discussion on observations that have been made can not be linked with the theory behind. Practical activities undertaken still verification, which is proving a concept or principle which has been discussed in the course of learning that will have an impact on the imprecision in drafting and drawing conclusions from a lab. This happens, because the learning of physics still implies a theoretical approach and a perceived lack of support generic skills of students, thus affecting the quality of learning is less efficient.

In addition to the conditions of learning by the student, teacher professionalism ability in mathematical modeling and inference logic low (Maman, 2013). Low ability mathematical modeling and inference logic indicates a low ability generic science. It is necessary to design an innovative learning can improve students' thinking skills. By designing the development of cognitive load theory of learning the physics learning in the classroom is more efficient and generic capabilities can also be good science.

According Brotosiswoyo, 2000, that the ability of generic science is an ability that can be used to study a wide range of concepts and solve problems in science. Order generic skills that science continues to increase, then it must be trained in the skills of learning in class by the teacher. Science students' generic skills can be improved by implementing experimental learning activities both in the classroom and laboratory. In implementing student learning by experimentation guided by activity sheet as a guide in learning physics.

Ability generic science students in learning physics that needs to be developed are: 1) the ability of direct observation, 2) the ability of mathematical modeling, 3) the ability of logical inference, and 4) the ability to build the concept. The ability to apply in peembelajaran physics by applying the theory of cognitive load.

This research was aimed to: (1) Improving the quality of the learning process of physics related to the ability of generic science students, (2) Developing a learning model of physics by applying the theory of cognitive load, (3) Device generates learning by applying the theory of cognitive load in the form of instructional design and learning outcomes instruments to improve the ability of generic science students.

METHODOLOGY

This study is a research and development that apply physics learning through cognitive load theory to improve the ability of students in materials science Ideal Gas Law. Development steps apply Dick and Carey model of design that consists of 10 steps, namely: 1). Identify the purpose, 2). Instructional analysis, 3). Analysis characteristics of students, 4). Formulate Instructional objectives, 5). Develop assessment instruments, 6). Develop learning strategies, 7). developing learning materials, 8). Designing and Implementing Formative Assessment, 9). revise learning, 10). Designing and Implementing the Summative Evaluation.

This study begins by analyzing the learning needs to specify learning objectives using cognitive load theory in implementing the learning of physics. Learning objectives can be obtained from the analyst needs of student learning, learning difficulties when teaching and learning of physics for this, the difficulty of teachers in delivering learning materials that affect student achievement is low, an overview of learning physics that has been only focused on the teacher just so generic capabilities science students has been less developed. Further analysis of the learners so that it can be determined learning steps using the Cognitive Load Theory. The next research step is to develop instructional strategies, assessment instruments, teaching materials that generate the data results in the form of product design learning materials, student worksheets, assessment test instrument. Development of achievement test conducted in small groups in class XI IPA at SMAN I Tanah Java consisting of 39 students. So that at the end of this research are used to revise the results of the evaluation of learning using cognitive load theory to improve the ability of generic science students. After learning implemented then given a questionnaire about students' learning model designed.

RESULTS AND DISCUSSION

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The results of the development of the learning device physics using cognitive load theory is focused on the development of learning and student worksheet using innovative teaching aids syringe to measure the ability of generic science students. The research activities of this development can be documented as follows:

Identify the purpose. The general objective of learning is based on the needs of students with the capability of beginning physics students before following study by applying the theory of cognitive load. Identify the learning objectives are developed from the basic competence of the "Analyzing the properties of an ideal monatomic gas is based on the data" Instructional objectives were identified uan to develop learning tools required are as: a). Prove that at constant temperature (T) gas pressure (P) is inversely proportional to the gas volume (V), b). Prove that the gas volume (V) at a constant pressure is proportional to the temperature (T) of the gas

Analysis of Learning. Analysis of the general purpose of learning is nothing that actually can be done only if the student has achieved the goal. Steps being taken to analyze the learning is: The first stage: identifying the cognitive skills by providing a response to a question, the answer or how to answer these questions, do not involve the manipulation of symbols. The second stage: identify about things that will be demonstrated as the achievement of learning objectives.

Activity 1: Experiment with Constant Temperature. In Boyle's experiments, used a pump which has a valve that can be closed. A number of pre-determined amount of gas, trapped inside the pump. The observation that Boyle became known as Boyle's Law which is mathematically expressed by the equation: p 1 V 1 = P 2 V 2 .....(1-2).

Equipment designed experiments using equipment syringe (syringe) large plastic (60 cc), closed with a rubber syringe tip so airtight. A pressure cylinder needles held together with a buffer. Large pressure gauge are:

$$P_g = \frac{F}{A} \quad \text{..... (1 - 3)}$$

Activity 2: Experiment with Constant Pressure. experiments Gay Lussac, if the vessel is heated, the temperature and pressure of the gas in the vessel will rise. Boyle's Law is mathematically expressed by the equation:

$$\frac{P_1}{T_1} = \frac{P_2}{T_2} \quad \text{..... (2–2)}$$

Students Characteristics Analyses. The development research conducted in class XI IPA-3 SMAN I Land Java district. North Sumatra Simelungun total of 39 students. Selection is on the basis of science majors interests and talents of students. Students' motivation is quite

good. Based on data collected before implementation of activities that students come from middle-class economic communities. Thus the behavior and characteristics of the early students generally assumed homogeneous in the following study physics. So that the delivery of learning materials using Worksheet students more easily done.

Instructional Objective Formulation. Specific learning objectives are detailed descriptions of what would be feasible students after completing a learning unit. The specific objectives on the basis of competence to analyze the properties of an ideal monatomic gas is based on data with cognitive load theory is: "Formulating law Boyle-Gay Lussac".

Developing Assessment Instruments. Instruments used are able to measure the performance of students in achieving the learning objectives. The instrument used is composed of material substance of the measure cognitive, affective and psychomotor. The instrument used to measure cognitive ability is in the form of essay, which is based is able to measure the ability of generic science students.

Developing Learning Strategies. Learning strategy refers to the various activities of teaching and learning process. starts from the ability of teachers open, presenting and closing the learning activities.

Developing Learning Materials. In developing learning materials are prepared starting from the development of learning materials are composed of teachers in the form of student worksheets. Student learning materials include: a. The general objective of learning, b. Analysis of learning, c. Specific learning objectives, d. Item test, e. Characteristics of learners, f. Characteristics of the performance context and the context of learning, g. The selection of instructional media in accordance with the instructional goals of students, and h. Development of formative evaluation of learning.

Implementation of formative evaluation is done to revise the products in order to obtain products that are more effective and efficient. Carried out on the collection and analysis of data and revisions. Two stages in the implementation of formative assessment are:

a. One to one or clinical evaluations conducted to identify problem-m a wrong suffered by the students so as to portray the characteristics of students to carry out the learning activities using cognitive load theory. The subjects used for the evaluation of one to o ne totaling 3 students aiming for member i comment on the learning device physics using the theory of cognitive load. Three students have different abilities, namely low-ability students 1, 2 students are capable, and 3 students capable than average (high). The responses given by the three students can be seen in Table 3.

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At the end of the questionnaire study conducted to evaluate the response of the students about learning tools such as worksheets Students are represented by a small group of 3 students with different abilities

The ability of students is not the same, which is composed of more than average ability, the ability of the average being and ability is below average. For the evaluation of one to one is composed of 6 pertanyatan to be answered students.

Questions for the teacher activities are: 1. Serving Information in L Work embar short, compact and easy to understand, 2. instructions or commands in the worksheet facilitate understanding of the implementation work, 3. The order of the worksheets from one activity to the next systematic, and 4. Instructions and examples to complete the worksheet

Table 3. Results of Student Response

No.	Question	Student 1	Students 2	Students 3
1	When you are learning the subjects of physics, for example, studied the kinetic theory of gases, what you feel most difficult to do? (Concept, reading graphs, mathematical formulas, symbols related material or unit)	Mathematical Formulation	Mathe matical Formu lation	The concept Mathe matical Formu lation
2	What do you feel is the most difficult to answer number 1 is also valid for topics other material?	Yes I Do Lack of knowledge of physics	Yes I Do Not Tau trick and do not understand	Yes I Do Difficult physics concepts
3	What efforts have you made to overcome these difficulties?	Learning continues	Keep repeating the lesson	The concept of repeated reading
4	Have you managed to overcome these difficulties? (Select one of the ways circled) A. Always B. Often C. Rarely D. never	Rarely Work on the problems with friends	Rarely Continue to be tried again but still failed.	Often Reading and exercises
5	Do you feel the difficulty to be overcome with the learning of physics that you follow today?	Yes I Do. But it remains difficult	Often agitated because do not know how to do it	Sometimes
6	Which do you think is more important to master that can equip you understand the concepts of physics to be more easily understood (select one of the ways circled) A. Being able to measure the hydrostatic pressure on the liquid with the experiment. B. Being able to interpret the physical meaning of the hydrostatic pressure measurement results Why?	A.	A Direct experiments makes it easy to understand	A Because apply themselves to Practice

The responses given by the students are presented in Figure 1.

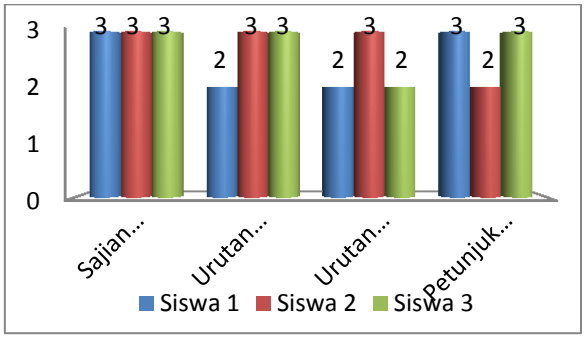

Figure 1. The results of student responses

b. The trial is limited to the actual class, involving about 39 students of class XI IPA 3 in SMA I Java. Test results conducted is the final revision stage in formative assessment.. Experiments performed tests of cognitive ability measured by menggunakaan instrument that can measure the ability of generic science students. The result is then dipersentasekan to see success.

Generic capabilities Science Students. Generic science students design capabilities by applying cognitive load theory outlined in the guide implementation of learning in the form of student activity sheets that have been made are: 1) Introduction, 2) Scenario Development of generic science capabilities developed by the Cognitive Load Theory, 3) manual steps for the implementation of learning in the form of student activity sheet on the gas kinetic theory of matter. Learning guide using cognitive load theory is encouraging how students perform science activities develop generic skills. This is done either when the teacher explains and in conducting attention to the effects of cognitive load.

Tabel 2. Generic capabilities Science Students

Material Events	MPA 1	MPA 2	KPM1	KPM2	KPM3	KIL1	KIL2	KIL3	KMKs
Constant temperature	69.74%	68.21%	77.44%	60.00%	69.74%	72.82%	69.74%	63.08%	62.05%
Constant pressure	84.62%	90.77%	84.1%	84.62%	77.44%	72.82%	68.72%	66.67%	60%
Physics phenomena	89.23%	89.74%	84.62%	62.56%	67.69%	88.21%	86.15%	-	-
On average	81.20	82.91	82.05	69.06	71.62	77.95	74.87	64.88	61.03

In an effort to apply the theory of cognitive load, both when the teacher explains and written information to guide the student activity sheet, presented by observing the ten aspects of cognitive load theory, namely: 1). for new concepts with concrete examples, 2) for the old concept with examples of limited settlement, 3) does not make terginya attention, 4) appropriate manner or form of present 5) is not excessive, 6) associate with the old concept, 7) elements of information insulated bulkhead, 8) for new concepts is given as an explanatory additional

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information, 9) for the old concept, additional information is reduced, and 10) clear and measurable objectives command.

Activity Sheet Keterlaksanaan students can demonstrate the ability of generic science students who have accomplished in the process of learning to encourage the development of generic capabilities of science students has been designed by the teacher. Perform it can be seen in Table 3. From Table 3 can be explained that the Work Capability Management (KMKr) high student reaches 100%, all of his students perform on sheet activities available. Direct observation varied capabilities, the ability to collect facts and experimental results of natural phenomena (MPA 1) reaches 100% while the ability to find a causal link from observations (MPA 2) reached 92.31%.

Tabel 3. Perform Student Worksheet

No.	Code	Capabilities developed	Okay	K. Good	Ill done	Amount	Percentage
			2	1	0		
1	KMKr 1	To manage their work in groups	39	0	0	39	100.00
2	MPA 1	Gather facts and experimental results of natural phenomena	39	0	0	39	100.00
3	MPA 2	Finding a causal linkage of observations	36	3	0	39	92.31
4	Kil 1	Digging logical consequence	39	0	0	39	100.00
5	KPM 2	Describe the physical meaning of a mathematical model, in the form of mathematical formulas	39	0	0	39	100.00
6	KPM 2	Describe the physical meaning of a mathematical model, in the form of mathematical formulas	37	2	0	39	94.87
7	KPM 1	Identify the relationship between symbols with each other	38	1	0	39	97.44
8	KPM 1	Identify the relationship between symbols with each other	39	0	0	39	100.00
9	KPM 3	Describe the physical meaning of a mathematical model is presented in the form of images / graphics	34	5	0	39	87.18
10	Kil 2	Logical conclude from the consequences of existing ones.	12	16	11	39	30.77
11	Kil 2	Logical conclude from the consequences of existing	5	19	15	39	12.82

Results Cognitive Load Theory in Physics Education. From the data obtained, the effect of cognitive load theory that arises is contained 5 Cognitive Load Theory effect. The effect is the effect of the 2nd, the "t idak given grain sample completion, the new concept" of 33.33%, the effect that the 3rd is "a dish that makes the division of attention," amounting to 66.67%, the effect of the ke- 5 is "Serving excessive" reaches 33.33%, 8 to the effect of "Do not be guided or instructed, the new concept of" reached 33.33% and the effect of the 9th "Too much coaching or guidance for the old concept of" reached 66.67%.

The results obtained can be explained that the effect of cognitive load obtained from the learning outcomes should not be too much of teachers respond to students. The emergence of these effects for the five new teachers start using cognitive load theory. During this learning is done more guiding teachers and active teachers while students are less active in learning. So the theory of cognitive less than the maximum load carried by the teacher. Students are expected to be active in this cognitive load theory so that students are more actively engaged in learning activities to develop generic skills of science not only as recipients of information but rather as information seekers.

The results of student responses on cognitive load theory studies. Students' response to learning of cognitive load theory very well. All students enjoy learning using Work Lembaar provided teachers .. positive student response to learning physics. Of 3 students who in turn to the response of the learning is in the category of "good" reached an average value of 2.667.

CONCLUSIONS

Based on the experimental results and a discussion of the problem, it can be concluded that the application of cognitive load theory can improve the ability of generic science learning materials physics at Kinetic Theory of Gases. Such improvements can be demonstrated by:

1. Generic science capabilities achieved by students achieve both categories. Achievement of generic capabilities developed science is Direct Observation Capability (MPA) reached 82.05%, Mathematical Modelling Capability (KPM) reached 74.24%, Ability Logic Inference (Kil) is 72.57%, Capability Building Concept (KMKs) reached 61.03%.
2. Achievement of learning models emerging cognitive load theory is that there are 5 effects. Fifth effect of cognitive load theory that emerged is the effect of the 2nd, the "t idak given grain sample completion, the new concept" of 33.33%, the effect that the 3rd is "s spell that makes the division of attention," amounting to 66.67% , effect-5 is " Serving excessive "reaches 33.33%, 8 to the effect of" Do not be guided or instructed, the new concept of "reached 33.33% and the effect of the 9th" Too much coaching or guidance for the old concept "reaches 66.67%. The emergence of the cognitive effects showed maximal teachers apply learning theory of cognitive load while the student is still a recipient of information that are active in the learning process.
3. Students' response to learning of cognitive load theory very well. All students enjoy learning using Work provided teachers. Positive student responses to learning physics. Of 3 students who in turn to the response of the learning is in the category of "good" reached an average value of 2.667.

From the results obtained, it is necessary to study the cognitive load theory re-use to maximize the learning stages of cognitive load theory in the learning process when merapkan curriculum in 2013 that the results are expected to improve the generic skills can be maksmial science and physics learning produced more efficiently.

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