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THE EFFECTIVENESS OF USING DEVELOPED PROBLEM BASED LEARNING TOOLS ON GENERAL PHYSICS II OF PHYSICS STUDENT, STATE UNIVERSITY OF MEDAN

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ABSTRACT

This study aimed to describe: (1) the effectiveness of the product development of problem-based learning tools to improve learning outcomes of general physics II among the student of Faculty of Mathematics and Natural Science, and (2) students' learning motivation after using problem-based learning tools. The learning tools used in this study are: (1) general physics textbook II, (2) problem-based student worksheet general physics II, and (3) a set of test results in general physics II. This type of research is a quasi-experimental design "one group pretest-posttest design". The populations of this study were students in physical education class I, State University of Medan. The sample was selected randomly numbered 30 people. There are two forms instruments used which are the test results of learning and motivation questionnaire. To analyze the data, it is used the gain normalization test and percentage. The results of this study illustrate that the use of product development software is quite effective problem-based learning (<g> = 0.56) in improving learning outcomes general physics II, and make the students sufficiently motivated (72.83) to learn more general physics.

***Keywords**: Problem-based learning, physics, learning outcomes, learning motivation*

INTRODUCTION

The outcomes characteristic of Faculty Mathematics and Natural Science students, State University of Medan is expected to have the same ability in the basic concepts of Mathematics and Natural Science. This course consists of: Calculus I & II, General Physics I & II, General Chemistry I & II, and General Biology I & II. It is a cumpulsory for all students to pass the Basic Mathematics and Science subjects.

To measure learning outcomes General Mathematics and Natural Science obtained from the competency test administered and implemented by the management team of Faculty of Mathematics and Natural Science. The Competency test conducted by the Faculty Team called formative three (F3). The test results for the last three years is still below the score of 70 (Sinuraya, et al., 2012) [1]. Score of 70 is the minimum score mastery of learning outcomes for all students.

The learning outcomes that still not achieved optimally cannot be seperated from the constraints faced by General Physics lecturer team on the field. The constraints are such as the

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number of students in a class is too much, the amount of material that must be taught is too much, student activity sheets have not been ready, and generally still use the Basic Physics book as the main source of student learning (Sinuraya, et al ., 2004) [2].

The presence of these constraints makes it difficult for lecturers to implement student-centered learning approach. The approach chosen is learning-centered approach to the lecturer. Lecturer-centered approach does not give space to the students for an interactive discussion, because lecturers control over all class information that they delivered to students (Al-Zu'be, 2013) [3].

Changing the study habits of students to actively participate in lectures is necessary to change the lecturer-centered approach to student-centered approach. Cornelius & Gordon (2008) [4] found that student-centered approach wash facilitated by flexibility in content deliver and study strategies, and individual students learning needs were accommodated.

Slunt & Giancario (2004) [5] called the student-centered approach as student-centered method. Student-centered methods explained that through the provision of teaching materials to students allow students to control the learning activities; they feel the need to take responsibility and be actively involved in learning activities.

One approach that is centered on student learning is problem-based learning. Nurhadi as cited in Handayani (2009) [6] explained that the problem-based learning is a teaching approach that uses real-world problems as a context for students to learn about critical thinking and problem solving skills, as well as to acquire the knowledge and the essential concepts of the material lessons, enrich and develop the knowledge, skills and attitude.

Essential problem-based learning for the provision of a variety of problem situations are authentic and meaningful to students who can serve as the foundation for students to conduct an investigation (Arends, 2008) [7]. In line with the views Arends, Nurhadi (2004) [8] define the problem-based learning is a teaching approach that uses real-world problems as a context for students to learn about critical thinking and problem solving skills, as well as to acquire knowledge and essential concept of the material lesson. Problem-based learning can improve critical thinking skills, communication, mutual respect, team work, improve interpersonal skills, and increase interest in learning (Gordon, et al., 2001) [9].

Jacobsen, et al. (2009) [10], called the term of teaching problem-based learning with problem solving, which is the solving the problem that begins with a problem in which the student is responsible to solve it with the help of the lecturer. Further explained, step-by-step problem-solving learning there are five, namely: (1) identify the problem, (2) confirms the problem, (3) selecting a strategy, (4) implementing the strategy, and (5) evaluate learning outcomes. Reasons for the selection problem based learning is due to the implementation can

accommodate students to empower creative thinking skills. Students are encouraged to express ideas that are varied and give students the opportunity to interpret a phenomenon or a demonstration, this activity can accommodate aspects of creative thinking skills that fluency and flexibility.

The next stage is students gather appropriate information to get an explanation and problem solving. Students can add original ideas in solving the problem. This activity will help students develop the aspects of authenticity.

Students then plan and prepare a report and present it to other friends in this activity are expected. Other students can add their ideas to enrich the ideas that have been presented, so as to develop the capability to elaborate.

The ability to judge will appear in the process of problem-based learning. Analysis and evaluation of problem solving, assisted by faculty, students give consideration to the resolution of a problem that has been put forward on the basis of the student's own viewpoint.

In addition, problem-based learning students are actively involved in finding problems and express alternatives solutions. The active involvement of students in each stage of learning makes students motivated to learn. Implementation of a student-centered learning can lead to increased motivation to learn, greater retention of knowledge, deeper understanding, and a more positive attitude on the subject being taught Collins & O'Brien, 2003) [11]. Student motivation is an essential element for the quality of education. When students are motivated, they pay attention, started tasks, answering questions and giving answers, and showinh the fun and excitement (Palmer, 2007) [12]. There are five elements that influence student motivation, namely: students, lecturer, content, methods / processes, and the environment. These five elements are only element method / process that can be manipulated by the lecturer. In this study a method / process called problem-based learning.

Application of problem-based learning and other learning models that make students as learning centers often fail or become less effective because the tools does not support the learning. Learning tools that have been produced in the previous activity is textbook and problem-based activity sheets in General Physics II course. The use of the product development is expected to improve the effectiveness and student learning motivation. To obtain empirical evidence, then do the research.

METHODOLOGY

This research was conducted at the Department of Physics, Faculty of Mathematics and Natural Science, State University of Medan. The population of this study was students of Physics Education, Faculty of Mathematics and Natural Science, State University of Medan

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2013. Using cluster random sampling technique, the sample is taken from a population of one class. Through the technique of random, determined members of the sample were 30 students.

Learning tools used in this study there are three types: a problem-based student activity sheet of General Physics II, General Physics II textbooks, and a set of test results of study General Physics II. This learning tool is a product development activity that has been carried out previously.

The type of this research is the quasi experiment, using the "one group pretest -posttest design" (Ary, 1985) [13], that described in Table 1.

Table 1. One Group Pretest-postest Design*)

Pretest	Treatment	Posttest
Y_1	X	Y_2

*)X = the use of problem-based instructional tools development products that is General Physics II textbooks and problem-based student activity sheets in General Physics II.

The instrument used in this study is a test result of learning, and motivation questionnaire. This instrument is a product development activity that has been carried out previously. Product development has been conducted trials are: validation by experts, individual testing, and testing of a small group. Overall trial results illustrate fit for use as a learning tool.

There are two data analysis techniques, namely: (1) calculate the average normalized gain, the average of pre- and post-test score, and (2) calculate the average score of motivation questionnaire data.

Determine the average normalized gain score used the following equation:

$$< g >= \frac{posttest\ score - pretest\ score}{\max imum\ score - pretest\ score}$$ (Bao, 2006) [14]

Furthermore, the score gain normalization <g> is converted into the effectiveness of adaptation of Hake (1999) [15] as in Table 2.

Table 2. Conversion gain scores normality <g>

Score gain <g>	Effectiveness
(<g>) > 0,7	Good
0,7 > (<g>) > 0,3	Enough
(<g>) < 0,3	Less

The average score of motivation to learn is also converted in the level of motivation to learning that adapted from the conversion value of State University of Medan 2014 as in table 3 below.

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Table 3. The Average score of motivation to learn

Average Score	Learning Motivation
90 – 100	Very high
80 – 89	High
70 – 79	Enough
0 – 69	Very low

RESULTS AND DISCUSSION

Based on the results of statistical calculations and data analysis, some research results summary described as in the following Table 4.

Table 4. Summary of average normalized gain calculation

Group/Test Frequency	$\overline{Y}_{Pretes}$	$\overline{Y}_{Postes}$	$<g>$	$<\bar{g}>$	Conclusion
Experiment Group					
1st Test	43.83	74.77	0.55	0,56	Quite Effective
2nd Test	43.80	75.40	0.56		
Control Group					
1st Test	42.33	66.50	0.41	0.44	Quite Effective
2nd Test	43.33	69.30	0.46		

Scores gain normality in product development classes using problem-based learning tools (experimental class) is higher than the score gain class that uses the conventional (control class), but the conclusions gain scores in the two groups are in quite effective category. This illustrates that the learning tools for this use has been quite effective in improving student learning outcomes Physics students, Faculty of Mathematics and Natural Science, State University of Medan. What matters is the average of the results of learning in the classroom using conventional learning tools products below the minimum standard score, while the average score of achievement of learning outcomes in the classroom that they apply above a minimum standard score. These differences illustrate that the effectiveness of the use of the product development of problem-based learning software gives a better indication than the use of conventional tools.

The not optimal achievement of learning outcomes General Physics II is due to several things, among others, that some of the stages of learning contained in problem-based student worksheet General Physics II has not been optimally by students, namely: data collection, discussion, and conclusions manufacture. Students choose a material not understand what is important and appropriate for the written part of data collection; students often move existing results on the internet or in books of physics, studies on the discussion very little (25%) linking the results of studies with the theory, and the making conclusions largely (70%) did not

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correspond with the formulation of hypotheses that have been defined previously. Weakness weaknesses illustrates that the understanding and experience of the stages of problem-based learning and preparing reports still lacking. These weaknesses should be minimized, if the stages of problem-based learning has been developed systematically in problem-based student worksheet General Physics II and guidance Lecturer done as well as possible by the students.

Another weakness is caused not optimal learning outcomes General Physics II is due to toxicity was less effective student learning. This is illustrated by the results of a questionnaire completed by 30 students gained some habits of students who are less well studied, namely: (a) 63% of students are not trying to remember formulas of physics, (b) 80% of students do not make a summary of learning, (c) 75% of students do not repeat the tasks that have been worked on and collected the Lecturer, (d) 93% of students in the habit of doing practice questions by looking at the formulas of physics in physics books or records. The fourth study habits illustrate less effective study habits. Given the formula, makes a summary of learning, relearn tasks that have been collected to the faculty, and train working on the exercises without seeing it first formula is an effective learning strategy, but the strategy has not been done by the students.

In addition to the lack of effective study habits, positive habit that needs to be appreciated is the involvement and enthusiasm of students when the session activity report presentation by each group. Students are quite active and debated between the presenters and discussants group. Besides being active in the debate discussion, students were quite excited tasks and mengumplkannya investigation in a timely manner. Correspondingly, Kennedy (2009) [16] found that after participation in a debate, the range of positive experiences on learning strategies to increase from 75% to 85%, including among students who were initially reluctant to participate become participate and become a force among the students.

The achievement of learning outcomes other is student motivation to learn. Students' motivation levels after using the product development of problem-based learning tools are motivated Puspitarini, et al. (2014) [17], concluded: "No effect of the use of teaching materials based enough (72.83). Relevant research findings, Integrated Science STAD to increase students 'motivation'. Anwar, et al. (2012) [18] concluded that the development of student activity sheet-based design of active-cooperative learning can improve their understanding of science concepts and generic skills of students. Wahyudi (2012) [19] concluded that the student worksheet inquiry can be used by students to develop a scientific attitude associated with detachment, critical, tenacious, humble, in collaboration with others, and a positive outlook towards failure.

CONCLUSION AND PROSPECT

The findings of this study illustrate that the use of problem-based product development is effective to improve learning outcomes General Physics and make the students sufficiently motivated to learn more General Physics II. Learning tools comprising: General Physics textbooks, problem-based student activity sheets General Physics II, and achievement test General Physics II.

The essence of science holds that science as products and processes. As a product, science is structured knowledge gained through the process of active, dynamic and exploratory of inductive activity (Carin, 1997) [20]. The nature of science direct the learning designers including Physics, State University of Medan lecturer to design learning that can make students active, dynamic, and able to explore the results obtained through learning activities that follow.

One of the very important component of learning is developing a learning tools in accordance with the approach or learning model used by the lecturer. Improvement efforts have been made to improve the quality and process of learning outcomes of General Physics II at Faculty Mathematics and Natural Science students, State University of Medan is developing problem-based learning tools. Development process begins with an analysis of needs relating to improving the learning outcomes of General Physics at Faculty Mathematics and Natural Science students, State University of Medan. The step-by-step for its development used the design models Dick and Carey. Structuring the content of learning contents, especially the problem-based student worksheet is compiled systematically and problem-based so-called problem-based learning. Problem-based learning can help students to develop the skills to think and solve problems, was studying the roles of adults, and become independent learners (Arends, 2007) [21].

The results of this research have the good prospects in the future because of the products produced in this research oriented to the needs of students, the nature of science, instructional design models, and activities-based model. Therefore this activity should be conducted continuously.

The product of this research and development can be used as one good alternative model to be applied in an effort to improve learning outcomes, especially in Faculty of Mathematics and Natural Science, State University of Medan.

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