

The Effect of the Implementation of Problem-Based Physics Learning to Improve the Students' Creativity

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Abstract— The competence of Senior High School students in mastering the physics lessons was still low, caused by several things, namely physics learning has not been fun, not yet interesting, and has not been challenging for students. There are still many students who have not been actively involved. Lesson plan, module, and students' worksheet that available have not been able to improve the students' creativity in solving problems, finding facts, concepts, principles, and laws of physics. One way to improve the students' creativity was through problem-based learning. The research aims to determine the effect of the implementation of problem-based physics learning to improve students' creativity. This research uses a quasi-experimental method with one group pre-test post-test design. The research subject was tenth-grade students of Senior High School. Data was collected using an observation sheet, interview guide, and creativity test. Data were analyzed by the normalized gain score and effect size formula. The results of the research show that the effect of problem-based physics learning to improve the students' creativity was include a large category.

Keywords: *problem-based learning, students creativity*

I. INTRODUCTION

One of the demands of the 2013 curriculum is student-centered learning using the scientific approach. The teacher acts as a facilitator, motivator, and an alternative source of learning. The teacher designs teaching materials that are in accordance with the demands of the curriculum that can teach students so that students master the competencies that must be set. In the 2013 curriculum core competencies and basic competencies have been determined by the Ministry of Education and Culture, but the strategy to achieve them and the teaching material used was prepared by the teacher as a professional to design them.

Science education (including Physics) must be prepared the quality students, namely students who are scientific literacy, have the attitude and high order thinking skills so that they are able to think critically, creatively, and solve problems [1]. One of the high order thinking skills that can be developed is creative thinking. Creative thinking skills must be possessed by

students in facing the era of globalization. Creative thinking skills can be taught in schools by practicing habits of mind. The mindset in question is the ability to find information, process, make decisions, and solve problems creatively.

The survey results in Senior High Schools in West Sumatra (four schools) show that the learning outcomes and creativity of students in Physics are still low. There are still many students (48%) who have not mastery learning of physics. Of the four indicators of creativity, what is seen is the fluency indicator of the activity of asking and answering teacher questions, the frequency is very small (15%). The low learning outcomes and creativity of students are caused by several things, namely learning physics has not been fun, not yet interesting, and has not been challenging for students, so students often think that physics is difficult to learn. In the learning process, students have not been actively involved in discovering concepts, principles, and laws of physics that can be applied to solve problems in everyday life. Learning activities do not provide opportunities for students to develop their thinking skills. Students are forced to remember various information without understanding the information. As a result, when students graduate from school, they are smart theoretically, but they cannot apply it.

There are still many teachers using the lecture method in learning even though there are those who apply student-centered learning, such as problem-based learning. Teaching material designed by the teacher was not yet in accordance with the characteristics of students and subject matter. Teaching material in the form of lesson plans, module, and students worksheet have not been able to foster the creativity of students in solving problems, finding facts, concepts, principles, and laws of physics so that the learning process is not maximum. This learning process has an impact on learning activities of students become less creative and passive, so students have difficulty in understanding the physics material. Teachers are less creative in developing teaching material that was in accordance with the characteristics of students. The teaching material used by teachers tends to be on the available

teaching material, regardless of the characteristics of students and subject matter.

One solution to overcome the problem of physics learning is to implement a problem-based learning model. Problem-based learning is a model that collaborates problem-solving and concept discovery in physics learning. Stages of problem-based learning support the achievement of students' creative thinking skills and have been widely tested in various countries. In learning with a problem-based learning model, creative thinking skills, and science process skills can be developed. Creative thinking skills are cognitive skills to develop new ideas, as the development of pre-existing ideas and skills to solve divergent problems (from various perspectives). Creative thinking skills are needed to solve problems. Creative thinking skills need to be trained continuously in learning activities so that students are able to solve problems. In physics learning, creativity was needed. Creativity can be achieved, including through creative thinking skills [1]. The development of creative thinking skills in students who start early can form thinking habits that are very beneficial for students. In addition to creative thinking skills, mastery of concepts cannot be separated in the learning process because mastery of concepts is a learning goal [2]. While following problem-based learning, active students solve problems, so students can build their own knowledge [3].

Creativity is characterized by the ability to create, present, invest, shape, produce something new through the ability of imagination [4]. This can be interpreted that creativity is a habit of creative thinking. Creativity moves the imagination to reveal new possibilities or new ideas as the development of ideas. This is useful in solving problems from a variety of different perspectives. Creative thinking is a new way of seeing and working on things that contain four indicators, namely fluency, flexibility, originality, and elaboration [5,6]. Creativity is the ability of a person to create, which is characterized by originality in imaginative expression. Fluency indicator includes the ability to (1) solve problems and provide many answers to the problem, (2) smooth in expressing ideas about problem-solving, (3) quickly seeing shortcomings on an object. Flexibility indicator includes ability; (1) using a variety of problem-solving strategies, (2) giving a different view of others to a problem, (3) Producing uniform ideas. The originality indicator includes ability; (1) using strategies that are new, unique, or unusual to solve problems, (2) provide examples or statements that are new, unique, or unusual. Elaboration indicator includes ability; (1) explain in detail, and coherently to certain answers or situations, (2) expand an idea [7].

In problem-based learning, students are given a real problem in everyday life, so students can develop their own knowledge in solving problems that encourage students to think creatively. Problem-based learning is chosen as a problem solution because it can train students' creative thinking skills. Students are encouraged to express varied ideas and provide opportunities for students to interpret phenomena. This activity can train indicator of fluency and flexibility in creative thinking skills. In the next stage, students collect information that is appropriate to get an explanation and problem-solving. Students can add original ideas in problem-solving; this activity can help students develop an indicator of originality.

Then students plan and prepare reports and present them to other students. In this activity, it is expected that other students can add their ideas to enrich the ideas that have been presented, thus developing an indicator of elaboration capabilities. Evaluation ability will appear in the problem-based learning process in the analysis and evaluation phase of problem-solving, with the help of the teacher, students give consideration to problem-solving.

Based on the conditions of learning that have been described, research is conducted by implementing a problem-based learning model in physics learning. The research problem is formulated as follows: How does the effect of a problem-based physics learning model to improve student creativity?

II. METHOD

The research used a quasi-experiment method with one group pre-test post-test design [8]. The research subjects were 32 students of eleventh grade in the Senior High Schools in Padang. The research steps are (1) conducting a preliminary survey, (2) making teaching materials and research instruments, (3) giving pre-test, (4) implementing problem-based learning (5) giving post-test, (6) analyzing and interpreting data. Research instruments are observation sheets, interview guidelines, and essay tests. The essay test to measure student creativity includes four indicators, namely fluency, flexibility, originality, and elaboration. Data were analyzed by the normalized gain score formula $g = (\text{post-test score} - \text{pre-test score}) / (\text{maximum score} - \text{pre-test score})$ [9] and effect size formula $d = M1 - M2 / s$ where $s = \sqrt{\{\Sigma(X - M)^2 / N\}}$ [10]. The gain score category is the high category if $0.7 < g < 1$, the medium category if $0.3 \leq g \leq 0.7$ and the low category if $0 < g < 0.3$. The effect sizes as small, $d = 0.2$, medium, $d = 0.5$, and large, $d = 0.8$. Increased creativity of students based on creative thinking skills before and after learning.

III. RESULTS AND DISCUSSION

A. 3.1. Results

Problem-based physics learning is conducted according to the stages of problem-based learning. At the problem orientation stage, the students are grouped to formulate the problem. Creative thinking skills developed are fluency and flexibility. At the stage of organizing students for learning, students design experiments. Creative thinking skills developed are fluency, elaboration, and originality. At the stage of the individual investigation, students conduct experiments. Creative thinking skills developed are fluency, elaboration, and flexibility. At the stage of developing and presenting the report, students present their work. The creative thinking skills that developed are fluency and originality. At the stage of analyzing and evaluating the problem-solving process, students conduct class discussions. The creative thinking skills that developed are fluency. To find out the effect of problem-based learning on student creativity, first found the increase students' creativity after learning. Furthermore, the effect of problem-based physics learning on the students' creativity was analyzed using effect size.

The results of the research show that the four indicators of creativity can be raised in problem-based learning. Based on the average percentage of each indicator of student creativity, it is known that the indicator of creativity that is mostly possessed by students is fluency thinking with a percentage value of 87.6%, while the creativity indicator that is least possessed by students is elaboration thinking with a percentage value of 71.6% as Table 1.

TABLE I. STUDENT CREATIVITY

Creativity indicator	Average (%)		
	<i>Pre-test</i>	<i>Post-test</i>	<i>g</i>
Fluency	68.4	87.6	0.6
Flexibility	60.6	82.9	0.6
Originality	65.7	73.8	0.2
Elaboration	62.0	71.6	0.3

The average creativity of students before problem-based learning is 64.2% and after learning is 80.0%. Student creativity after learning includes good categories. Increasing student creativity after learning can be seen by calculating the average normalized gain score ($\langle g \rangle$) from the creativity score before and after learning. After going through the data analysis process, obtained the average score $\langle g \rangle$ is 0.44. Increasing student creativity after learning is included in the medium category.

The impact of problem-based physics learning on student creativity is analyzed by the effect size formula on students' knowledge competencies. The effect of problem-based physics learning to improve the competency of Senior High School students in Physics lessons has an effect size of 2.9. These results indicate that the effect of problem-based physics learning on student learning outcomes includes a large category.

B. Discussion

The results showed that problem-based physics learning had an effect on improving the student creativity. Creativity is the process of students using their thinking skills. Creativity includes the competence of the domain of knowledge. Therefore the assessment of students' creativity uses complex description questions. Based on the analysis of students' creativity in the first session, there were still many students who were low in creativity. This is because, in the first session, students are not familiar with the learning model used. They find it difficult to follow the stage of problem-based learning. In problem-based learning, students are given problems that must be solved through hypotheses and tested by experiments. Activities like this can improve students' curiosity to learn more about the teaching material. The ability to solve physics problems is influenced by problem-based learning. The ability to solve physics problems is influenced by student creativity [11]. The implementation of problem-based learning models can improve students' creative thinking skills [12,13,14]. Besides that, in problem-based learning, there are experimental activities, discussions, presentations, and make reports.

In problem-based learning, creativity indicators are raised so that these indicators can be developed in students. In every

session, the creative indicator is trained continuously so that it becomes a habit for students. The impact is an increase in student creativity. One of the internal factors in learning is habit [15]. Learning habits are a person's learning behavior that has been embedded in a relatively long time so that it gives a characteristic in the learning activities.

Increasing student creativity is the impact of problem-based learning. Problem-based learning models influence students' creative thinking skills [16-18]. Increasing student creativity occurs because problem-based learning helps students to develop creative thinking skills [19,20]. One step to teach creative thinking and enhance the creative thinking of students is to provide opportunities for students to express their creative thinking power. One design of the learning model that providing opportunities for students to think creatively is problem-based learning [21]. To obtain a high increase in student creativity, it takes a relatively long time. This is to familiarize students with these creativity indicators. In this research only conducted for four sessions, the resulting improvements were still in the medium category. Creativity requires a process of learning, so it takes a long time to develop these skills. The solution is to use some teaching material in the next research so that more learning sessions. The ability to think is always developing and can be learned [22].

Increasing students' creative thinking skills on each indicator is explained as follows.

1) Fluency thinking skills

Students who have fluency thinking skills can provide many and complete answers. Improved fluency thinking skills are included in the medium category. These results indicate that students are able to think divergently, which is to produce thoughts with many ideas [7]. This happens because, in the problem-based learning process, students are very enthusiastic about finding problems and solving problems.

2) Flexibility thinking skills

The increase in flexibility thinking skills was the medium category. Learning outcome in problem-based learning is the development of flexible knowledge, where learners know multiple strategies and adaptively choose efficient strategies [23].

3) Originality thinking skills

Increasing the originality indicator is quite difficult because students are familiar with teacher-centered learning so that their creativity does not develop. This is evident from the experimental design made by students when the learning process takes place is not much different from the sourcebook. Students lack confidence in their own thoughts, so students look for a comparison with a book to strengthen their confidence in the truth of the experimental design they made.

4) Elaboration thinking skills

The increase in the elaboration indicator was the medium category. This happens because when the problem-based learning process, students can find problem-solving. Students can make experiment procedures to solve the problem, and students can specify goals, tools, and materials, experimental steps, observation tables, data analysis, and conclusions.

IV. CONCLUSION

The results of the research show that the four indicators of creativity can be raised in problem-based learning. Based on the average percentage of each indicator of student creativity, it is known that the indicator of creativity that is mostly possessed by students is fluency thinking, while the creativity indicator that is least possessed by students is elaboration thinking. Problem-based physics learning had an impact on increasing student creativity. Increased creativity of students, including the medium category. The impact of problem-based physics learning on students' creativity includes a large category.

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