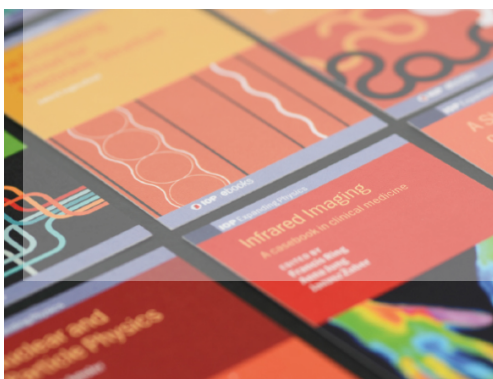


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The effect of problem based learning supported by computer simulation student's creative thinking skills

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Abstract. Generally, student's have low score of creative thinking skills. The students who have a low creative thinking skills will be difficult, in solve the problem. Creative thinking skills will increase learning process. This research aims to determine the effect of PBL with computer simulation towards student's creative thinking skills. The research method use a pretest-posttest design. The subject of this research are three classes, with experiment1 class simulation supported with computer simulations used PBL, PBL use the experiment2 class, and the control class use conventional learning. The instrument use essay tests that measure creative thinking skills based on problem. The average of pretest and posttest in experiment1 class are 20.28 and 76.62 with N-gain of 71%, in experiment2 class 20,84 and 68,06 with N-gain of 60%, and in the control class 20,35 and 44,05 with N-gain of 30% and all of that classes in the medium category. Based on the results of testing that there is significant difference obtained on PBL applied supported with computer simulations towards student's creative thinking skills.

1. Introduction

The 21st century is very necessary skills to be able to maintain his existence in the society so that the students should be provided skills in the learning process. The skills required in solving the problem [1]. Skills are also needed to help students in the face of the future. The skills needed for learning in the 21st century, namely: creative and innovative; information processing; problem solving, use of media and technology; and life and career skills. Among these skills, creative thinking and problem solving is part of HOTS Think creatively, critically and ask is part of the intelligence[2].

One of the skills students need to have is a creative thinking skills. Creative thinking are the skills to develop or find ideas, ideas, and original ideas, which is associated with the view and the concept and emphasize the intuitive and rational thought, especially in the use of information and materials that will come or explain with original perspectives [3], creative thinking skills one step higher level thinking required of students in society, and life are constantly confronted with the problem. Creative thinking skills needed to solve the problem, because when students are confronted with problems that students can make alternative solutions to problems. Students tend to be less able to solve the problem because it has a low creative thinking skills. The importance of creative thinking skills are not in accordance with the field. The fact the field of creative thinking skills of students is low. Lack of creative thinking



skills resulted in a learning atmosphere that is boring and monotonous. This kind of learning is less honing creative thinking skills for students which just listen to what is conveyed by teachers and learning only unidirectional.

Based on the experience of researchers, learning physics class did not expose students yet in everyday life and rarely support students' creative thinking skills. Creative thinking skills of students is low because the learning process conducted is still traditional classroom or teacher-centered learning, but it also rarely confronts student teachers to the problems of life associated with the concept of physics[3][4]. The low level of students' creative thinking skills makes it difficult for students to learn physics because physics is an application in everyday life, which contains a lot of phenomena and problems of daily life that can be solved using the concepts of physics.

Creative thinking skills can be improved through the use of appropriate learning, one of which is problem based learning (PBL). PBL is a learning that is designed to help students develop creative thinking skills, problem solving and intellectual abilities, become independent learners and autonomous[5]. The essence of the model PBL is a learning based on problems that require investigation authentic and real PBL can practice the skills to think critically, construct knowledge, collaboration, which can affect learning outcomes, be a good problem solver and lifelong learners. PBL can make students have a high creative thinking skills [6]; PBL can deeper understanding of concept [7], PBL exposes students to the problem to find the solution, so that learning can be imagined more significantly because based learning in everyday life. PBL process, students are able to identify and solve problems with their own ideas and the ability to develop creative thinking skills [4].

Application of PBL and learning process of physics need to be assisted by the media, for example by computer simulations because the concept of abstract physics, requiring experimentation activities, and multi-representation. Simulations has many benefits, especially to describe and clarify a situation or phenomenon that is abstract, difficult to describe and very interactive. This makes the animation physics simulation abstract. Computer simulations could give an opportunity for students can develop their skills in scientific investigation and inquiry. Computer simulations can also train solving [8]. The application of simulation in teaching could have implications for the development of new knowledge, creative thinking and good communication. The use of computer simulations media can increase scientific creativity because students are encouraged to continue thinking in the search for alternatives to solve problems in everyday life [9]. PBL supported with computer simulations can enhance students' creativity [10]. Learning using ICT can enhance creative thinking of students. Therefore, the purpose of this research is to find out the effect of applying PBL supported with computer simulations on creative thinking skills of students.

2. Methods

The study was conducted in one of the high schools in Medan academic year 2018/2019. The study population was all students in grade XI consisting of 6 classes. The study sample consisted of three classes of XI Science 3 as the experimental1 class which implement PBL supported with computer simulations, a class XI Science 2 as the experimental2 class implementing PBL models, and XI Science 4 as the control class that implements traditional learning. Sampling with simple random sampling technique. This research method experiment with control group pretest-posttest design. The study design is shown in Table 1.

Table 1. The Experimental Design of Group Control Pretest-Posttest

Class	Pretest	Treatment	Posttest
experiment 1	O1	X	O2
experiment 2	O1	Y	O2
Control	O1	Z	O2

The research instrument used creative thinking skills test description totaling 10 items. Indicators creative thinking skills consists of four aspects: fluency, flexibility, originality and elaboration. The material taught in this study is a static fluid with the material sub Hydrostatic pressure, the Law of Pascal, the Law of Archimedes, and Viscosity.

For the experimental class 1, by applying the PBL supported with computer simulations. The first stage to present a problem to the students, which Media used in this study PhET and Adobe presented problems related to the daily life of the second day. Case organizing students to learn. In this case, the students formed a discussion group as directed by the teacher. Fellow group collaborate, interact, gather information from various sources, discussions and brainstorming idea to try to resolve the matter at hand. The third stage, the teacher guide and facilitate individual and group investigation. The fourth phase, guiding and facilitating teachers prepare students for work in the form of solving problems with the investigation results obtained through experiments and has been compared with the results of computer simulations. The fifth phase, analyze and evaluate the problem-solving process. After completion of learning, then do posttest. Data pretest and posttest results were analyzed using one-way ANOVA test with those of normal condition and homogeneous with a significance level of 0.05. Normality test were analyzed using the Kolmogorov-Smirnov test and Pretest and posttest data were collected using the help of Statistical homogeneity test was analyzed by Levene's test of equality of error variance.

3. Results and discussion

The results of the data analysis skills of creative berpikir based penelitian detailed results are shown in Table 2. Experimental 1 class applied PBL supported with computer simulations, experimental2 class applied PBL, and grade control applied to conventional learning. pretest and posttest data creative thinking skills showed in Table 2. Based on Table 2 can be said for the data that the average pretest pretest for the third class is almost the same while the data posttest for the third grade, the average class creative thinking skills highest first experiment compared the two other classes. Third improvement creative skills in different categories. (SPSS) 23were analyzed using one-way ANOVA test shown in Table 3.

Table 2. Data on Creative Thinking Skills

	N	The mean pretest	Std. deviation	Mean posttest	Std. Deviation	N-gain	Category
experiment 1	35	20:28	2:08	76.62	14.90	71%	high
experiment 2	33	20.84	2:16	68.06	14:49	60%	moderate
control	34	20:35	2:42	44.05	11.60	30%	low

Tabel 3. Analysis Anova SPSS One Line

	Sum of Squares	df	mean Square	F	Sig.
between groups	19544.06	2	9772.03	51.67	.000
within groups	18719.93	99	189.09		
total	38264.00	101			

Based on Table 3 it can be concluded that the application of computer simulation models aided PBL positive impact on creative thinking skills compared to the traditional model of PBL and other words that the PBL learning supported with computer simulations help of computer simulations better than PBL and traditional learning. Increased N-gain can be specified based on indicators of creative thinking skills are: fluency, flexibility, originality, and elaboration. Percentage increase in N-gain creative thinking is shown in Figure 1.

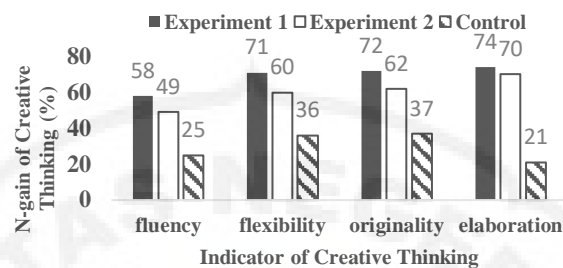


Figure 1. Based on the Creative Thinking Skills Improvement Indicators

Based on Figure 1 increase in N-gain creative thinking skills of experiment1 class was the highest compared with experiment2 class and class controls for each indicator. Increased N-gain creative thinking skills can be reviewed by the static fluid Hydrostatic pressure, Pascal's Law, the Law of Archimedes's, and Viscosity. Based on Figure 2 in terms of the material being taught, regarding to N-gain the highest creative thinking Hydrostatic Pressure materials and Pascal's Law respectively by 57% while the N-lowest gain was in Viscosity with an increase of 43% of creative thinking. This indicates that the Hydrostatic Pressure, Pascal's Law, and the Law of Archimedes. Besides considered more difficult, question of material is a material part of Fluid Viscosity Static considered more difficult than the sub-material Viscosity less than the question on another matter.

The results showed that the average achieved creative thinking skills students are taught PBL supported with computer simulations better than PBL models without the aid of computer simulations and conventional learning. The reason is because the model PBL supported with computer simulations requires students to work together in a small group to identify issues, conduct investigations, show results dan provide creative ideas to solve the problem. For example, the material of the buoyancy of Archimedes Law, students are difficult to understand the concept of buoyancy working on an object. Computer simulations show how the buoyancy acting on the object when placed in water to show the directions of forces acting on the body. Computer simulations can also be done repeatedly so that it can help students who still do not understand, can help students to explore their capabilities by varying the variables of physics that exist on a computer simulations so that the learning process as it can train the creative skills of students in addition to understanding the concept is increasingly deep. This is supported by several studies that claim that PBL supported with computer simulations can enhance creative thinking skills.

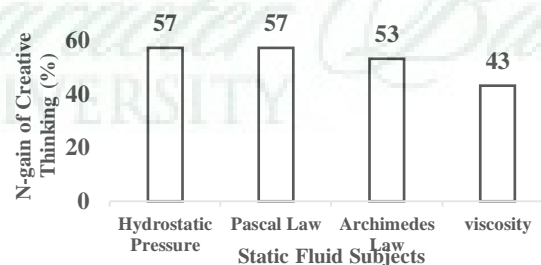


Figure 2. Creative Thinking Skills Improvement Based Materials

Application of PBL models more effectively enhance creative thinking skills because phases of PBL requires students to be more active in learning. The first phase PBL models, provide orientation problems. Teacher in charge to deliver the learning objectives, the benefits of learning, provide physical problems associated with static fluid material and give students motivation to solve the problem. Students are asked to identify a problem, hypothesize, ideas, suggestions and ways to solve problems that can develop aspects of current thinking. For example, the teacher presents the problem of Hydrostatic Pressure, when someone diving in the sea at certain depths ear ache. So that students can develop creative thinking skills in aspects of fluency.

The second phase of PBL models, organizing students to learn. Teachers form the students in discussion groups and organize learning tasks associated with the problem. Students interact with each other trying to give and receive information, discussion and discordant opinions to resolve the problems that exist with a variety of answers. For example, to solve the problems of each member in the group has the solutions to problems in a way that is different. Students can exchange opinions in solving problems with the variation of the answer to solve the problem so that students can develop the flexibility aspect. Students can also train elaboration aspects as students develop ideas variations of each member of the group.

The third phase, the investigation of individuals and groups. Teachers encourage students to get the right information, carry out experiments, searching for an explanation and a solution. Student activities to work together to solve the problem existing in the students worksheet, stringing experimental device, experimental design and prove the hypothesis through experiments. For example, students developed the concept of the law of Archimedes to find out the real or fake gold with gold dipping into the fluid and measure the fluid spilled. Object observation observe activity that stimulates an idea of thinking oneself to be different with other groups to develop aspects of originality. The data obtained can be used to determine the density of the gold. Object observation observe activity that stimulates an idea of thinking oneself to be different with other groups to develop aspects of originality.

The fourth phase, develop and present the results. Teachers assist students in planning and preparing the work of the right, such as research reports on the results of original thinking students. This activity can develop students' ability to contain results of originality for his thinking in the research report and trying to find answers that are different from other groups so as to produce something new.

The fifth phase, analyze and evaluate the problem-solving process. Teachers help students to reflect on their investigations and processes used. Activity Students analyze the data obtained from the results of the experiment, presented the results in front of the other group, answered questions and express opinions during a presentation corresponding appropriate learning resources so as to increase flexibility and elaboration skills. Teachers act as facilitators and help for those who have difficulty understanding the concept of a static fluid. Master computer aided simulation provides reinforcement concepts to students. One example of simulation used by teachers can be seen in Figure 3.

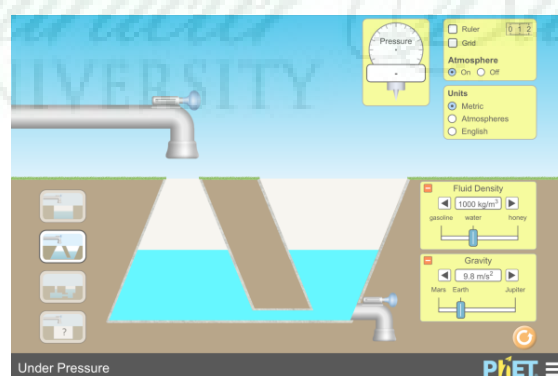


Figure 3. Computer Simulation of Hydrostatic Pressure

Based on Figure 3 computer simulations to facilitate teachers in presenting the concept of Hydrostatic Pressure. Experiments on computer simulations can be varied, for example, varying the type of fluid, gravity and the shape of the container. Hydrostatic pressure can be measured by placing a pressure gauge on the simulation at certain depths.

Based on the above, it can be concluded that the activities at each stage of PBL requires students to think creatively. This is supported by the stated that the model PBL able to encourage creativity and learning outcomes [11]. PBL models can help students with the process of non-routine problem solving by maintaining uncertainty and increase creative thinking [12]. Also states that the PBL model is able to increase creative thinking skills [13].

Creative thinking skills students are taught PBL supported with computer simulations better in each indicator compared PBL models without the aid of computer simulations and conventional learning. Students are taught by PBL-aided simulation models and models of PBL alone increased N-highest gain in the indicator elaboration. That's because the model PBL requires students to solve problems through experimentation begin with identifying the problem, stringing tool lab, experiment, develop the findings obtained and displays the results of the experiments so that students are trained to solve problems step by step and in detail. Increased N-gain fluency lowest indicator. This happens because the students are not accustomed to answer the question with many possible answers, often students feel satisfied just by presenting one idea or solution to the problem.

4. Conclusion

Based on the results of this study concluded that PBL with assisted by computer simulations was more effective in improving creative thinking skills on Static Fluid material compared PBL and traditional learning. Improved creative thinking skills in the high category.

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