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STEM-Based Project Based Learning Model to Increase Science Process and Creative Thinking Skills of 5th Grade

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Abstract

The background that drives this research is not yet honed the skills of the process of science and creative thinking. The aims of this research is to know the effect of STEM based learning based learning model on science process skill and creative thinking. The study was conducted on the water cycle material and its use. The research method is Quasi Eksperimental Design. The sampling technique is saturated sampling. The data collection tools in the form of observation instruments of science process skill, and instrument of creative thinking. The data were analyzed using independent t-test to test the difference. In testing the increase and effect of using N-gain. The result of the research shows that there is difference of influence of creative thinking skill, this is seen from the average of N-gain pretest and posttest in the students. The findings of the research are the significant increase of creative thinking skills in the experimental class 1. Improving creative thinking skill which in the high category is 23% and the middle category is 77%. In the experiment class 2, the high category is calculated as 4% and 96% are categorized into the medium category. The conclusion of the research is the learning model of learning based project based learning STEM can improve the skills of science process and creative thinking of the students. Learning based project based learning STEM is expected to be a reference in the application of learning.

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INTRODUCTION

Developing students' potential in creating an idea in science is not an easy effort. In order to develop the potential of science and technology of students today, it is necessary to improve the ability in various fields of education (Suyanto et al, 2012). One of the areas that need to be improved is the field of Natural Science. This is in line with Murnawianto et al, (2017) who states that science education can improve the thinking skills needed in the 21st century.

One of the skills required is the skill of the science process. By applying the science process skills students are able to develop the knowledge it possesses (Nasrullah et al, 2015). But of course in the process of creating products, students also need creative thinking skills. Skills in creative thinking are used primarily in introducing problems and designing experiments, so it is needed by students (Aktamis & Erign, 2008). Creative thinking skills are also needed to propose an alternative problem-solving (Suyanto et al, 2012). To solve a problem it is not enough to rely on intelligence, it also use creative thinking skills (Sulistiarmi et al, 2016). Creative thinking skills are required for students in the future (Yunianta et al, 2012). However, the skills of the science process and the creative thinking skills are still less owned by the students.

Scientific process skills and creative thinking skills can certainly be generated through appropriate learning models. The appropriate science learning model for elementary school children is a learning model that adapts students' learning situations to real-life situations in the community. Students are given the opportunity to use the tools and learning media that exist in their environment and apply them in everyday life. Learning at school also sometimes still has not properly developed those skills.

Learning methods that are able to apply the skills of the science process, thus producing scientific products is project based learning. In simple terms, project-based learning is defined as a teaching process to relate between technology and daily life issues that are familiar to students or to school projects. Bédard (2016) mentions that the project based learning method is able to develop students' thinking skills, develop student creativity, as well as to encourage students to work together in a team.

In addition to project based learning, the current learning needs to keep up with the times. In the era of globalization one of them by integrating Science, Technology, Engineering, and Mathematics (STEM). Tsupros (2009) says that STEM is an interdisciplinary approach study academic concepts that are engaged with the real world. By applying the principles of science, mathematics, engineering and technology, it wise connecting between schools, communities, jobs, and the global world. STEM model also provide space for the development of STEM literacy. So they have the ability to compete in the new economic world. The linkage between science and technology and other science can not be separated in science learning. STEM is a discipline of science that is closely related to each other. Science requires math as a tool in processing data. Technology and technique is the application of science. STEM approach in learning is expected to produce meaningful learning for students through systematic integration of knowledge, concept and skill. Some of the benefits of the STEM approach provides students to able to solve problems for the better human beings, innovators, inventors, independent, logical thinkers, and technological literacy (Morrison in Stohlmann et al., 2012).

Research on STEM integration in project-based learning is still rare. The results of Tseng et al, (2013) revealed that STEM integrated project based learning can increase students' learning interest, learning becomes more meaningful, helping students in solving real-life problems, and supporting future careers. In addition, STEM in project based learning poses challenges and motivates students for training critical thinking, analysis and enhancing high-level thinking skills (Capraro et al, 2013).

Based on the above description, the purpose of this study is to analyze the significant differences in the creative thinking skills of the class that apply the STEM-Based Project Based Learning model with the class that applied the

Learning Based Learning model only. By analyzing the significant differences in the science classroom process skills to apply STEM-based Project Based Learning model with a class that implements the Learning Based Learning model only. It also to analyze the significant improvement of creative thinking skills in the students following STEM based project based learning model.

By applying STEM-based Project Based Learning, students have an opportunity to explore their scientific and technological literacy. It can be appear form of reading, writing, observing, and doing science so that it can be used to live in society and solve problems encountered in daily life related to the field of STEM science (Mayasari et al, 2014).

METHODS

The design of this research using Quasi Experimental Design research method. With the form of Nonequivalent control group design. The experiment was conducted in two classes given different treatment, that is experimental class 1 treated using STEM based project based learning model while in the experimental class 2 group was treated using Project Based Learning model only. The research procedure consists of the initial observation stage, the research planning stage, the implementation stage, and the data analysis phase.

The sampling technique is saturated sampling with the amount of 62 students. There are two classes of 5 which are sampled, namely class 5A as experiment class 1 (EC1) and class 5B as experiment class 2(EC2).

Data collection techniques used in this study is an observation technique with an instrument in the form of observation skill in the process of science and test technique with the instrument in the form of test of creative thinking skill.

Data analysis techniques consisted of pretest data analysis, instrument data analysis, and impact analysis of STEM based project based learning model on science process skills and creative thinking skills. Analysis of pretest data is used to determine normal distributed samples. Analysis of instrument data in the form of learning device validation and analysis of creative thinking skills with validity test, reliability test, difficulty level, and appropriateness to obtain valid question. Independent t-test analysis to analyze differences in science process skills and creative thinking skills, and N-gain test to analyze the improvement of creative thinking skills.

RESULTS AND DISCUSSION

Analysis of the Differences in the Influence of Creative Thinking Skills

The differences in the influence of creative thinking skills initially calculate the pretest used the difference test is formulated independent t-test. The data used for independent t-test is the result of the pretest of the experimental class 1 and the experimental class 2 The independent t test results are analyzed using SPSS 16.0 for windows. The test results are different from the pretest grade of EC1 and EC2, shown in Table 1.

Table 1. Results of Pretest of Experimental Class 1 and Experimental Class 2

Class	N	Sig value count	Sig value 5%
Experimental 1	31	0.000	0.005
Experimental 2	28		

Based on Table 1 the sig (2-tailed), the value of 0.000 < 0.005 and according to the decision of independent t-test, it can be concluded that H_o is rejected and H_1 accepted. This means that there is a difference of pretest between EC1 and EC2. However, before looking for differences in the effect of pretest and posttest learning results first seek improvement of student learning outcomes using N-gain test from pretest and posttest learning outcomes from EC1 and EC2 as shown in Table 2.

Based on Table 2, it shows that the average increase in students' creative thinking skills on pretest and posttest in experimental class 1 is 0.67 while in experimental class 2 is 0.54. Thus, it is concluded that there is a difference between EC1 and EC2.

Table 2. Improvement results of Creative Thinking Skills of Experimental Class 1 and Experimental Class 2

	Experimental Class 1			Experimental Class 2		
	Pretest	*Posttest*	N-gain	*Pretest*	*Posttest*	N-gain
Average	57.90	85.96	0.67	51.96	78.1	0.54

The significant difference between the EC1 and EC2 the test using independent t-test with help SPSS 16.0 for windows. In this calculation obtained from the value of N-gain EC1 and EC2 has a Sig. (2-tailed) of 0.000 < 0.05. That in decision-making in the Independent Sample t-test, if the significance value or Sig. (2-tailed) < 0.05 then H_0 is rejected and H_1 is accepted, which means that there is an N-gain difference between the experimental class 1 and the experimental class 2.

Differences in Process Skills Improvement

Differences in the improvement of science process skills among students taught using STEM-based project based learning model and only taught using project based learning model only, are shown in Table 3.

Table 3. Recapitulation of Observation Value of Student Science Process Skills

Class	Meeting			Average
	1	2	3	
Experimantal 1	56.2724	72.40143	88.89	72.52
Experimental 2	53.0465	71.50538	86.55	70.37

Based on Table 3, it shows that the average increase in science process skill in EC1 is 72.52 while in EC 2 is 70.37. Thus, there is a difference in the improvement of science process skills between those taught by STEM-based project based learning model and that is only taught using a learning-based learning model only. In this calculation, the average value of science process skill through students' worksheets and observation in EC1 and EC2 has a sig (2-tailed) value of 0.000 < 0.005. That in decision-making in the Independent sample t test, if the significance value or sig (2-tailed) < 0.05, then H_0 is rejected and H_1 is accepted, which means that there is a difference in mean score of science process skill between experimental class 1 with experimental class 2.

The Influence of STEM-Based Project Based Learning Model

The influence of STEM-based project based learning model in EC1 and learning of project based learning in EC2 was analyzed by using N-gain formula (Sugiyono, 2010). Gain is the difference between the value after treatment and before treatment, the gain indicates the improvement of students' creative thinking skill after using STEM based project based learning model. The N-gain result for the improvement of creative thinking skills in the EC1 is presented in Table 4.

Table 4. The Results of the Improvement of Creative Thinking Skill in Experimental Class 1

Score	Criteria	Total	%
N-gain ≥ 0,70	High	7	23
0,30 ≤ N-gain < 0,70	Fair	24	77
N-gain < 0,30	Low	-	-
Total			100

Based on Table 4, the creative thinking skill in the EC1 received a high criterion of 23%. While, those who get the fair criterion are 77%. The result of N-gain in experiment 2 class for improvement of creative thinking skill will be presented in Table 5.

Table 5. The Results of the Improvement of Creative Thinking Skill in Experimental Class 2

Score	Criteria	Total	%
N-gain ≥ 0,70	High	1	4
0,30 ≤ N-gain < 0,70	Fair	27	96
N-gain < 0,30	Low	-	-
Total			100

Based on Table 5 of creative thinking skill in experimental class 2, those who get high criterion equal to 4%. While those who get the fair criterion are 96%. So, it can be concluded that STEM-based project based learning model is more influential in improving creative thinking skills.

Based on the the Independent T test, it can be seen that the value of learning result which is the creative thinking skill on pretest obtained the

Sig (2-tailed) value of 0.000 < 0.05. T, in decision-making of the Independent Test t-test, if the value of significance or sig. (2-tailed) < 0.05 then H_0 is rejected and H_1 is accepted, it means that there are differences in pretest and posttest values between experiment 1 and experiment 2.

The calculation of N-gain EC1 and EC2 has a sig (2-tailed) value of 0.002 < 0.05. In decision-making in the Independent test, if the significance value of sig. (2-tailed) < 0.05, which means there is difference of N-gain between EC1 and EC2.

Based on the explanation above, it can be concluded that there is a difference in the influence of creative thinking skill of EC1 applied STEM-based learning with EC2 that is taught using learning based project learning model only. Different types of components in the environment of learners that can stimulate learners to learn. This means that there is an indication to identify information in creating technology. In this case, STEM information technology strongly supports computerized technology.

The use of computerized technology to support the creation of student creativity is also in line with the opinion of Prawiradiliga (2004) which states that through computer technology/internet learning will be able to create an adaptive learning environment both to the level of initial understanding and learning preferences of each learner. Through the learning process with the help of computer/internet this learning process become more efficient and create a more productive learning environment.

In order to measure student learning outcomes in the form of creative thinking skills, teachers can do product evaluation. So that the results of learning in creative thinking has been achieved. Susanto (2013) categorizes learning outcomes in three domain. First, the understanding of concepts (the cognitive aspect) is the ability to explain and interpret something, not just to know but really understand by being able to give pictures, examples, and explanations. Implementation of STEM-based project based learning model can be concluded to improve students' creativity rather than learning based project model only. The model of learning based project either based on STEM or not, is able to make the learning process becomes more active, creative, and fun.

The result of data analysis shows that there is a difference in the improvement of students' science process skills through the application of STEM based learning project based learning model with the application of project based learning model only. The average score of students science process skill in EC1 is 72.52 while in EC2 is 70.37. Based on the average of observation, it indicates that the improvement of process skill in project based learning model based on STEM is higher than the application of project based learning model only.

By linking the skills of the process of science, students are expected to master the concept and apply it in everyday life. Ambarsari et al. (2012), argues that a student will easily remember the acquired knowledge independently longer than the information he or she gets from listening to others. Sukarno et al, (2013) also mentions that science process skills are a crucial skill for students in the future. Scientific process skills are a direct practice for developing cognitive, affective and psychomotor aspects. In addition, science process skills can also enhance students' creativity through motor skills and motor activity throughout the project (Omar et al, 2014). Wardani (2008) also revealed that having a science process skill is able to direct the growth and development of other skills in students to be able to process information so that they can find new useful things. So the science process skills are very suitable to be developed in the students.

Based on the above explanation, it can be concluded that STEM-based project based learning model enables students to be more active and responsive in facing existing problems in the environment, as well as more creative than project based learning only. Through the STEM-based project based learning model, students are able to determine the concept of learning and linking with real-life applications.

The influence of STEM-based project based learning learning model and project based learning only in improving creative thinking skill

between EC1 and EC2 were calculated using N-gain formula. Improving creative thinking skills in the high category with 23% percentage and in the medium category that is 77%. While in experimental class 2 that is taught using learning model of project based learning only get 4% for student categorized as high level and the result 96% in medium category.

The above description shows that the improvement of creative thinking skills of students using STEM-based project based learning model is higher than that of students using only project based learning model. STEM learning is able to increase motivation, creativity and provide experience on problem solving using technology while according to (Sumarni et al., 2016) project based learning can improve students' ability in psychomotorik. So that project based learning and STEM are able to go hand in hand and support each other.

Based on the exposure, it can be concluded that STEM-based project based learning model can give influence to improve students' creative thinking skill. By applying STEM-based project based learning, students have scientific and technological literacy that appears from reading, writing, observing, and doing science so that it can be used to live in society and solve problems encountered in daily life related to the field of STEM science.

CONCLUSION

Based on the study of theory and analysis of the results of research that has been put forward in the previous chapter, it can be concluded that. STEM-based project based learning model can improve students' creativity rather than learning based project model only. The model of learning based project either based on STEM or not, are able to make the learning process becomes more active, creative and fun. STEM-based project based learning model enables students to be more active and responsive in facing existing problems in the environment, as well as more creative than project based learning learning only. Through STEM-based project based learning model, students are able to define the concept of learning and link it with real life applications. STEM-based project based learning model is able to give influence to improve students' creative thinking skill.

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