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The Effectiveness of the Integrated Project-Based Learning Model STEM to improve the Critical Thinking Skills of Elementary School Students

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Abstrak

The purpose of this study was to analyze the effectiveness of the STEM-integrated PBP model to improve the creative thinking abilities of elementary school students. This type of research is a quantitative research method with a control group pre-test post-test design. The study population consisted of all grade IV students in Tersono District, Batang Regency. Samples were selected through a purposive sampling technique, so that selected class IV SD Negeri Rejosari 01, amounting to 20 students as an experimental group and SD Negeri Tersono, totaling 23 students as a control group. Data collection techniques used to test techniques, the results showed that the experimental class's creative thinking skills reached 85% classically with an average value of 80.75; while the creative thinking ability of control class classically only reaches 56.52% with an average value of 76.74. The N-gain score of the experimental class reached 0.51 with the medium category while the N-gain score of the control class only reached 0.33 with the low category.

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INTRODUCTION

Human activities cannot be separated from thinking activities. One of the activities of thinking is when solving problems or determining the right strategy for making decisions. One's ability to think must be developed through teaching and learning activities in schools. Doing learning in school is the interaction between the teacher and students to do the thinking process. The process of thinking in learning is carried out interactively, inspiratively, fun, challenging, motivating students to participate actively, as well as providing space for the initiative, creativity, and independence following the interests, talents, physical development and development of students' thinking skills.

Students' creative thinking skills cannot develop properly if the learning activities of teachers do not actively involve students in understanding the formation of concepts, learning methods used in teaching and learning activities that are less creative, and learning is still teacher-centered. These learning activities hinder the development of creativity and student activities in terms of communicating ideas or ideas they have. These activities are no longer in line with the national education paradigm and the challenges of education in the 21st Century.

The National Education Standards Agency (2010: 41) says that the 21st Century national education paradigm is to develop human beings who are creative, independent and critical without leaving insight into responsibility. The 21st Century education paradigm becomes a reference in the implementation of education in Indonesia. Efforts to realize the ideals of the Indonesian nation continue to be done, one of which is to improve in all aspects of education.

But the fact is Indonesia's educational achievement is still relatively low at the world level. According to the 2015 Program for International Students Assessment (PISA) report, Indonesian students' achievement scores for science, reading, and mathematics rank 62, 61, and 63 of the 69 countries evaluated. The low achievement and performance are due to creativity and motivation to learn Indonesian students who have not been optimal.

The results of the evaluation are supported by Stacey (2012: 9) who examines the level of literacy that has been achieved by Indonesian students from 2000 to 2009 the level of achievement of Indonesian students' literacy abilities when viewed from scores achieved values below 400 with the highest cognitive abilities on average can only reach levels 3 and 4. Low literacy and students in Indonesia can cause students to lack creativity. These problems require a paradigm in the education system that must be able to provide a set of 21st Century skills needed by students to deal with every aspect of global life.

21st Century education demands that emphasize the competence of students who have the ability to think creatively, the ability to work together, and the ability to communicate. Competence is obtained so that individuals can survive and compete to face challenges and develop students' potential in 21st Century education. However, in its development in Indonesia, education that is able to develop student competencies has not been seen significantly. Even though Indonesia has been faced with students 'preparation to look at 21st-century education, which contains education that provides many life skills as the development of students' potential (Mayasari, 2016).

Developing students' potential to create ideas in knowledge is not easy. Developing students' potential in science and technology requires an increase in their abilities in various fields of education (Suyanto, 2012). The fields that need to be improved are Natural Sciences (IPA). This is in accordance with Murnawianto (2017) which states that natural science education is able to improve the creative thinking skills needed in 21st-century education. Science education has a role as a means of creating a nation's next generation of quality in facing challenges in the globalization era (Sari, 2017).

According to Kamala (2008) said that science learning seeks to arouse human interest

and ability to develop science and technology as well as means of understanding about nature that have facts that have not been widely revealed scientifically.

Technology and science also have a close relationship to make scientific product breakthroughs by scientists (Adolphus, 2012). So that requires creative thinking skills in making these scientific products. These creative thinking skills are used in introducing problems and designing experiments, therefore students are very much needed. Creative thinking pregnancy is needed by students as a provision in the future (Yunianta, et al, 2012).

Creative thinking skills can be taught through appropriate learning models. The appropriate science learning model. The learning model that is suitable for elementary school-age children is a model that adapts student learning situations in real life. Students can be given the opportunity to use existing learning tools and media in the environment and apply them in their daily lives (Samatowa, 2006) learning in class sometimes still does not develop these skills.

Facts that occur in the field, learning science in elementary schools are still focused on cognitive improvement only. Learning that is done is still not activating students. The fourth-grade teacher at SDN Rejosari 01 revealed that he more often applied teacher-centered learning. Sometimes learning discovery learning is applied, but learning this model only produces achievements in understanding concepts. Students are rarely actively involved in scientific product discovery activities in learning.

Learning in class ends on solving problem problems on the subject matter. Learning for one semester is only 10% applying project-based learning. Project-based learning that is carried out usually only looks for material sources such as pictures. It is rare to apply scientific product manufacturing projects so that students' creative thinking skills are not optimal.

Based on the above problems, innovative models, strategies, and methods that are able to apply creative thinking skills and increase student motivation are needed. The learning model according to Trianto (2012: 51) is a planning of a pattern that is used as a guide in planning learning in class or learning in a tutorial. Learning models that can be used are project-based learning models.

The project-based learning model according to Mahendra (2007: 109) is a learning approach that gives students the freedom to plan learning activities, carry out collaborative projects, and ultimately produce work products that can be presented to others. Bedard (2016) said that project-based learning is able to develop students' thinking abilities, develop student creativity, and encourage students to work together in groups or teams.

Project-based learning is expected to be able to create a student environment that can build meaningful, active, and student-centered learning and build students to collaborate.

Research on the project-based learning model has been carried out by Komang, et al (2016) entitled "The Effect of PjBL Learning Model on Science Learning Outcomes of Class IV Students in Elementary School 2 in Rendang District" shows the results that project-based learning (PjBL) has a positive effect on learning outcomes of Natural Sciences fourth grade elementary school students in the second semester in Cluster 2, Rendang Karangasem District.

Another study conducted by Ardianti (2017) entitled "Implementation of Project-Based Learning (PjBL) with Science Edutainment Approach to Student Creativity" shows that the average creativity score of students in the experimental group is 7.52 and 6.78 for the control group.

The use of PjBL with the science edutainment approach gives a significant influence on students' creativity. Yager (2002) revealed that one of the advantages of project-based learning is that it helps students solve real-world problems through collaborating with groups. Project-based learning can encourage students to solve problems in terms of relevant knowledge and skills.

In addition to project-based learning, the learning process must also keep up with the

times, in the current era of globalization learning can be associated with nuances of Science, Technology, Engineering, and Mathematics (STEM). Tsupros, et al (2009) said that STEM is an interdisciplinary approach to learn various academic concepts that are side by side with the real world that applies the principles of science, mathematics, technology, and engineering that are connected between schools, communities, jobs, and global worlds so as to provide space for development STEM.

STEM is a scientific discipline that is closely related to each other. Science requires arithmetic as a tool in processing data, technology, and techniques used as applications in science. The STEM approach in learning is expected to produce meaningful learning for students through the systematic knowledge, concepts and skills presented.

METHODS

This research uses quantitative research methods in the form of a quasi-experiment design.

The design used in this study used a control group pre-test post-test design. The population in this study were all grade IV students in the Tersono District of Batang Regency who were registered in the odd semester of the 2019/2020 school year.

This sample was taken with a purposive sampling technique which is the determination of the sample with consideration. Class IV SD Negeri Rejosari 01 as an experimental class and class IV SD Negeri Tersono as a control class based on the consideration of average IPA learning outcomes that are relatively the same. Data collection techniques for students' problem-solving abilities are carried out through test techniques in the form of problem descriptions and reinforced with interviews and documentation.

Data were analyzed using simple statistical formulas for prerequisite tests consisting of data normality tests and data homogeneity tests.
It also uses the classical completeness test, the average difference test (Independent Sample t-test), and the N-Gain test.

FINDINGS AND DISCUSSION

The strength of this research lies in learning activities, especially in making projects in the form of color discs for the experimental class. At the beginning of learning activities, students practice the properties of light including, such as light can propagate straight, light can penetrate clear objects, light can be reflected, light can be refracted, and light can be decomposed.

The next activity is making color discs with the help of technology in the form of a portable fan. The activity of making color discs aims to prove that the white light of the sun is a collection of colors called a spectrum. The activity of making color discs concludes that if a color disc is rotated it will produce white which is the basic color of all colors. Color disc manufacturing activities can also improve students' creative thinking abilities.

STEM integrated project-based learning (PBP) model effectively improves students' creative thinking abilities. This increase can be seen from the results of the study as follows.

Test of Prerequisite Students' Creative-Thinking Ability

Normality Test

The normality test is intended to measure whether the data obtained has a normal distribution. The hypothesis proposed is; H0 = sample data come from populations that are normally distributed; and Ha = sample data not derived from populations that are normally distributed, with testing criteria H0 accepted if Sig> 0.05. The normality test results of the control class and the experimental class can be seen in Table 1.

Table 1. Data Normality Test Result

	Kolmogorov Smirnov		
	Statistic	F	Sig.
Experiment Class	0.175	20	0.111*
Control Class	0.169	23	0.087*

The normality test in this study used the Kolmogorov Smirnov test because the study sample was> 50, based on the results in Table 1, the Sig value from the experimental class posttest was 0.111. While the posttest results in the control class show a Sig value of 0.087. Data is said to be normally distributed if Sig> 0.05 significance level. Therefore, it can be said that the control class and experimental class data are normally distributed..

Homogeneity Test

A homogeneity test is carried out to investigate whether or not homogeneity is fulfilled invariance or group. The following homogeneity test results are presented in Table 2.

Table 2. Homegeneity Test Result

Levene Statistic	df1	df2	Sig.
0.464	1	41	0.500

Decision making and concluding the hypothesis test carried out at a significance level of 5%. If the significance is more than 0.05, it can be concluded that the variance is the same (homogeneous), but if the significance is less than 0.05, the variance is different. Based on the homogeneity test results in Table 2, the Sig value obtained is 0.500> 0.05, so it can be said that both classes of samples are homogeneous.

Test the Hypothesis

Average Difference Test

Table 3. Different Test Results of Students' Creative Thinking Abilities

Sig. 2 tailed	Significance level	Mean Control	Mean Experiment
0,00	0,05	71,73	80,5

The average difference test is used to test the average difference of students between the control group and the experimental group. This test uses an independent sample t-test. The following picture 2 presents the average results of students' creative thinking abilities of the experimental class and the control class.

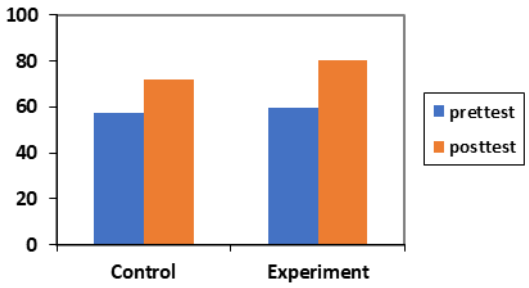

Figure 1. Results of Students' Creative Thinking Abilities

Based on Figure 1, it can be seen that before the learning of light material and its properties in the control class, the results of tests of creative thinking ability of students obtained an average of 57.17 which is in the sufficient category, then after learning the light material and its properties in students' creative thinking skills experienced an increase in results in the amount of 71.73 which is in the good category.

Before learning using the STEM integrated PBP model in the experimental class, the results of the students 'creative thinking ability test obtained 59.75 results in the sufficient category, then after learning to use the STEM integrated PBP model the results of the students' creative thinking ability test increased to 80.5 which is in the very good category. The following Table 3 presents the results of the SPSS calculation related to the average

difference test of the creative thinking abilities of the control class and experimental class students.

Based on the results in Table 3, it was obtained Sig of 0.00 <0.05, then according to the decision making basis of the independent sample t-test, it can be concluded that H0 was rejected and Ha was accepted, meaning that there was a difference between the average creative thinking ability of the experimental class students and control class. In the mean box, it can be seen that the average creative thinking ability of students in the experimental class is 80.5 while the mean creative thinking ability of students in the control class is 71.73. This shows that the average creative thinking ability of students in the experimental class is higher than the average creative thinking ability of students in the control class.

Hypothesis Test N-gain Score Creative Thinking Ability

N-gain results in the experimental class showed 0.51 and N-gain in the control class showed 0.33. N-gain in the experimental class is in the medium category. N-gain in the control class is included in enough categories. the conclusion of the results of the N-gain in the experimental class and the control class that the N-gain Test results are higher than the results of the N-gain control class.

Based on the data obtained, the application of the STEM integrated PBP model for the experimental class is more effectively applied in learning activities. This is reinforced by research conducted by Rikardus (2019) STEM approach that is associated with the environment so that learning that presents the real world experienced by students in daily life is realized. This means that through the STEM approach students are not just memorizing concepts, but rather how students understand and understand the concepts of science and their relationships in everyday life. The implementation of natural science learning through the STEM approach in VIII grade students of SMP Negeri 11 Kupang with excretion system material can increase student creativity.

CONCLUSION

Based on the results of the research that has been described can be stated that there are differences in the results of students' creative thinking abilities that use the STEM integrated Project-Based Learning model in learning activities. Based on the research results, learning using a model using the STEM integrated PBP model is more effectively applied in learning activities. The average difference test results show that the average creative thinking ability of students in the experimental class is higher than in the control class. Furthermore, the results of the N-Gain test of creative thinking skills in the experimental class are included in the moderate category.

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