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Implementation of STEM Approach Based on Project-based Learning to Improve Creative Thinking Skills of High School Students in Physics

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Abstract. Indonesia continues to improve the quality of education, especially in science learning. Science learning in Indonesia is not oriented yet towards improving 21st-century skills. Therefore, to develop science learning, it is necessary to improve the process thinking skills to release the potential that students have about creative thinking solutions that can be used to apply the STEM (Science, Technology, Engineering, and Mathematics) learning approach. Based on the results of preliminary research, the researchers focused this research on the implementation of the STEM approach which is oriented towards project-based learning to enhance student's creative thinking. This research was conducted to find out the improvement of students' creative thinking skills by applying a STEM approach oriented to project-based learning on Pascal's law material. This research was conducted at SMAN 1 Blambangan Umpu in the first semester of the 2019/2020 academic year. The results of the study represent that the application of the STEM learning approach to pascal's law has increased the creative thinking skills at a significant level of 0,000 and there are differences in the increase in students' creative thinking skills before and after the application of the STEM learning approach.

1. Introduction

The use of technology in the world every year is increasing and developing. Developing and increasing technology can be seen in real life. Technology brings everyday life into the educational environment, providing tools to enhance learning and increase the opportunities for students for feedback, deliberation and capacity building [1]. The ever-evolving technology provides a good impact on life, as it can facilitate all human affairs. Improving and developing technology not only requires knowledge, but skills are also needed. This is by the 21st century, in the 21st century is time to develop technology with skill skills that have. The skills used are the thinking process skills done while doing cooperation to deepen understanding. There is a wide range of thinking skills, which are used to deepen the understanding of creative thinking skills. Creative thinking skills are a student's thinking skills to find many answers to many of the problems and questions gave [2- 5].

Studies show that creative potential can be nurtured [6]. Digging into the potential of creative thinking can be done by implementing a STEM learning approach (Science, Technology, Engineering, and Mathematics). STEM approach is an approach that uses four areas of science into one in unity, namely knowledge, technology, engineering, and mathematics [7-10] In addition to using the approach, a learning model is also needed to support creative thinking skills. One of the learning models used by learning how to improve students ' creative thinking is a project-based learning model



approach. A project-based approach is Project-based learning is learning by using the project as a learning method [11, 12].

Preliminary research has been conducted at SMA N 1 Blambangan Umpire. The results of this preliminary study were conducted to review how creative thinking skills are performed by students. Looking at the issues in preliminary research, the researchers have researched the implementation of a project-based learning STEM approach to improve creative thinking in high school students. The application of such approaches so that students better understand the physics not only by using formulas and questions, but also come into contact with the tools and everything that exists in everyday life related to physics.

2. Method

This study was conducted at SMAN 1 Blambangan Umpu school year 2019/2020. The class studied was XI MIA 2 class which amounted to 33 people. This study was conducted in 2 times meeting on Pascal legal material. This research will use the approach of science, technology, engineering, and Mathematics (STEM) to improve students' creative thinking skills.

This research using quasi-Experimental research with the research design applied to this research is One Group Pre-test Post-test Design. The research plan is as follows:

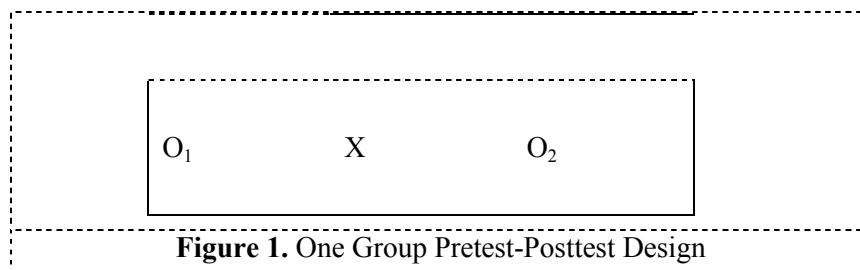


Figure 1. One Group Pretest-Posttest Design

Description:

O_1 = Pre-test

O_2 = Post-test

X = Implementation of STEM approach

The study used data collection techniques using mixed methods. Mix methods are a research approach by combining quantitative and qualitative research. Quantitative data on this study was obtained by conducting a pre-test and post-test on students while qualitative data was obtained by conducting interviews on students after learning. The sources of data are a syllabus, RPP (Learning Implementation Plan), LKPD (students' worksheets), learning materials, instruments about creative thinking skills, and protocol interviews.

3. Result and Discussion

Learning with STEM approaches can be combined with a variety of learning models, it is based on the research conducted by [13] which discusses the STEM approach, PjBL learning model, and STEM-PjBL on science learning. The science learning that complies with the STEM approach is the Project-based learning model.

Results obtained in this research form of qualitative data are the data obtained from the results of interviews by students after doing the research and quantitative which is data of creative thinking skills students from the results of pre-test and post-test. The increased creative thinking skills were measured by providing a pre-tests problem to measure students' initial skills before being prepared for learning with a STEM approach and providing post-test problems to gauge student's final skills after being applied Learning with a STEM approach.

The instrument used for pre-test and post-test in the implementation stage has previously been tested for its validity and reliability to determine whether or not the instrument is valid for use and to determine the level of reliability. The validity test obtained 10 questions declared as valid. The number of respondents to the validity test was 14 students with $\alpha = 0.050$ so that the R_{table} was 0.4575. Based on the results in table 8 can be seen that 10 questions are declared valid due to the R_{count} score of $> r_{table}$ with $\alpha = 0.050$ so the problem can be used to measure students' creative thinking skills. The reliability test is done after the validity test and reliability test is done to the problem that has been declared valid. Reliability test results show that the instrument is a matter of reliable research to use.

Assessment of creative thinking skills in students is derived from pretest and posttest results consisting of 10 reasoned double choice questions. The following is the result of the pretest and posttest data that the student acquired.

Table 1. The results of Pre-test, post-test, and N-Gain

Parameters	Pretest Score	Posttest Score	N-Gain Score
Lowest score	30	55	0,1
Highest score	65	90	0,8
Standard deviation	9,75	8,84	0,13
Average score	51	73	0,4

Based on the table above, it is noted that the score of students' pre-test is only reaching 51, after the treatment using the STEM model occurs increased achievement of 20 points so that the average post-test score is 73. This means that there is an increase in students' creative thinking after the STEM approach. Improved creative thinking skills can be seen in Figure 2.

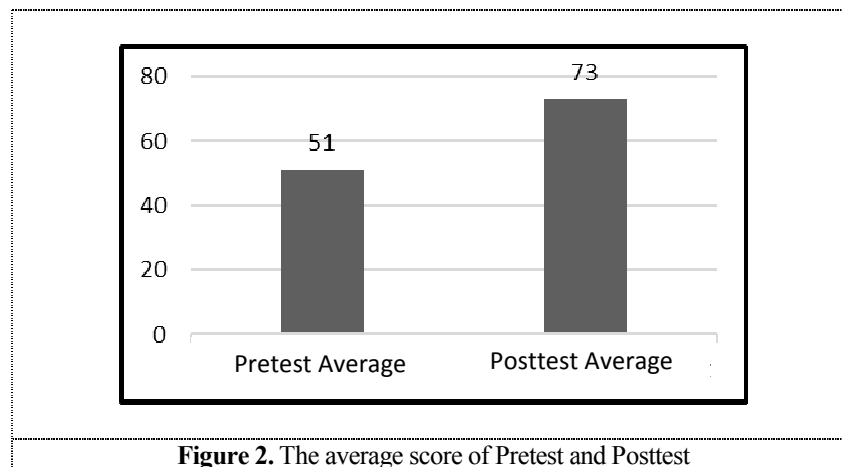


Figure 2. The average score of Pretest and Posttest

After being given treatment with the STEM approach, there is an increase in students' creative thinking skills. This can be seen based on the score of N-gain with moderate criteria which means learning by applying a STEM-down to improve students' creative thinking skills. This is in accordance with the research conducted by [14] stating that the LKS developed with the STEM approach can improve skills with N-gain score in moderate criteria, making it clear that learning with Using the STEM approach can improve students' creative thinking skills.

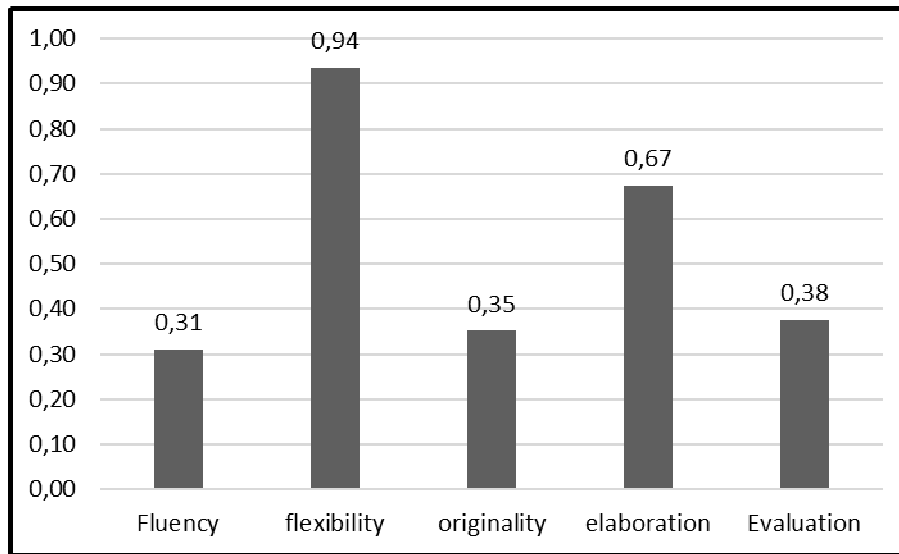


Figure 3. N-gain of Each Creative Thinking Indicator

Based on Figure 4 The calculation result of N-gain each creative thinking indicator is different. Results of N-gain calculations in terms of fluency, flexibility, originality, elaboration, and evaluation. The creative thinking indicators of the N-gain results in the medium category are fluency, originality, elaboration, and evaluation while the creative thinking indicators of the N-gain result in the high category are in the flexibility indicator.

Based on the N-gain score, it is concluded that the learning approach using the STEM approach can improve students ' creative thinking. The results of the pre-test and post-test responses of one of the students are in Figures 5 and 4.

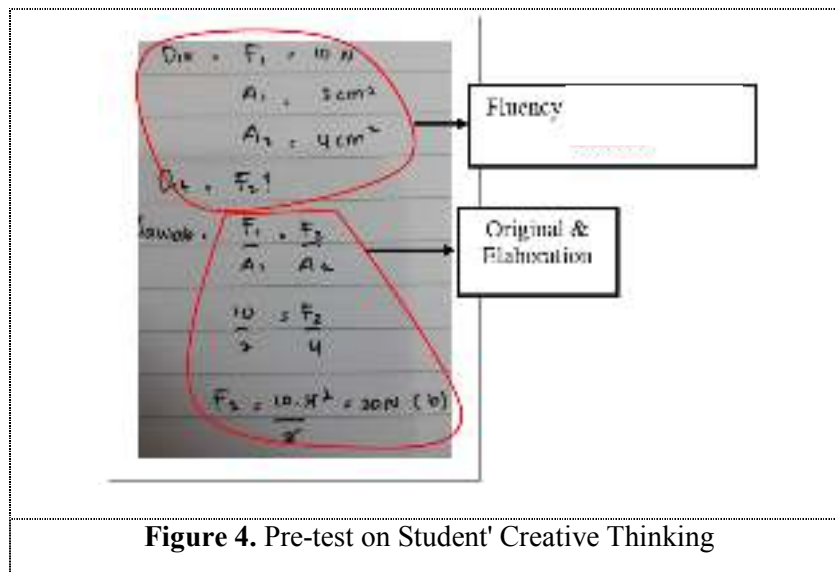


Figure 4. Pre-test on Student' Creative Thinking

Figure 4 shows the students' answers before conducting the project-based STEM approach. The results of the students ' written answers only meet the fluency of indicators, originality, & elaboration. Students are skilled in writing what is known and asked, it is Products that the registered students meet

the indicator of smooth thinking (fluency) is an identifying problem. But an answer in detail and accompanied by the steps, although registered there is to be less precise so that the students have not fully fulfilled the indicators of originality & elaboration. Results of pre-test students can be seen that a creative thinking student is still low. After that, students study using the STEM approach given by the post-test. The results of the post-test answer can be seen in Figure 5.

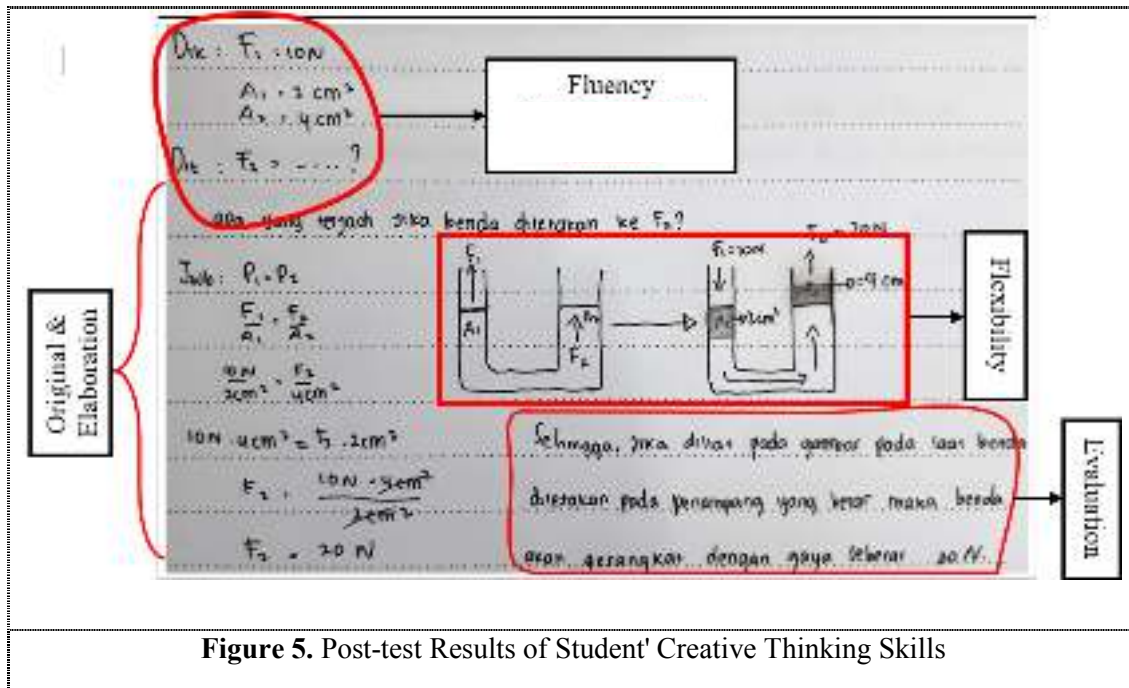


Figure 5. Post-test Results of Student' Creative Thinking Skills

Figure 5 is the result of the post-test after using the project-based STEM approach. From the picture above, it can be seen that students are skilled in writing what is known and asked. It has already fulfilled the indicator of fluency thinking that is the skill to identify the problem. Students are also skilled in describing the scheme of Pascal's vessel after being given pressure on the answer sheet as a manifestation of the idea of flexibility skills that are skilled in interpreting a problem with the help of images. Students have been skilled in detailing the answers in the appropriate steps, and this means that students already have original & elaboration skills, and students are able to use the concept of evaluating the worked-in responses marked By writing a summary of the answers that have been done, that means that students already have evaluation skills, so that it can be said that after the STEM approach students have been able to work on the problem by fulfilling Indicators of creative thinking skills, namely fluency, flexibility, original & elaboration, and evaluation. Based on both images, it is found that there is an increase in students ' creative thinking skills after setting up a project-based STEM learning approach. This is in accordance with the research of [15] which states that the STEM approach can make students create problem-solving creatively and can bring out students ' creativity and curiosity.

Quantitative Data the students ' creative thinking skills assessment will also be tested for normality as a condition for conducting hypothesis tests. The results of the pre-test and post-test data normality tests are visible in the following table.

Table 2. The Normality Test Results on Creative Thinking skills

Aspect	Sig	Category
Pretest	0,088	Normal
Posttest	0,173	Normal

Data on normality test results show that the significance score in the pre-test sig data. $(0.088) > \alpha$ (0.050) and post-test sig. $(0.173) > \alpha$ (0.050) , so it can be concluded that both data are normally distributed.

Paired samples T-tests were conducted to determine whether or not there is an increase in the creative thinking skills before and after the STEM approach was applied. The following are the results of the Paired sample T-test.

Table 3. Paired Sample T-test Result

Pair	Std. Deviation	T	Df	Sig.
Pretest-Posttest	7,494	-16,84	32	0,00

According to the table, it is known that, with a significant level of 5%, the score of SIG. $(0.00) < \alpha$ is 0.05 then H_0 is rejected and H_1 is accepted, so it can be concluded that there is a change before and after implementing the STEM approach oriented to project-based learning to improve creative thinking skills.

Based on the results of interviews with students, learning using the STEM approach can make them easier to understand the material presented and get the phenomenon that occurs in daily life. This is in line with the opinion of [16] stating that STEM is capable of enhancing the mastery of knowledge and phenomenon occurring in the environment.

4. Conclusion

Based on results and discussion, it is concluded that the STEM approach can improve students' creative thinking and improved the indicators of creative thinking skills. The indicators of creative thinking in the moderate category are originality, elaboration, and evaluation while indicators included in the high-level category are flexibility.

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