**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. Learning science in Indonesia is not oriented yet towards improving 21st century students' skills. Therefore to develop science learning, it is necessary to improve the process of thinking skills to release the potential that students have about creative thinking solutions that can be used to apply the learning approach STEM (Science, Technology, Engineering, and Mathematics). Seeing the problems that there is in the preliminary research, so the researchers do some research about 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 describing 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 odd semester of the 2019/2020 school year. The results of study represent that the application of the STEM learning approach to pascal's law has increased the expected ability to think creatively at a significant level of 0,000 and there are differences in the increase in students' creative thinking abilities 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. The ever-evolving technology provides a good impact of life, as it can facilitate all human affairs. Improving and developing technology not only requires knowledge, but skills are also needed. This is in accordance with the 21st century, in the 21st century is a 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 are a wide range of thinking skills, which are used to deepen understanding of creative thinking skills. Creative thinking skills are a student's thinking ability to find many answers to many of the problems and questions given[1,2,3,4]. Students ' creative thinking skills can be developed through learning experiences[5].

Digging into the potential of creative thinking can be done by implementing a STEM learning approach (Science, Technology, Engeneering, and Mathematics). STEM Adoption can enhance the creativity of the students thinking[6]. STEM approach is an approach that uses four areas of science into one in unity, namely knowledge, technology, engineering, and mathematics [7,8,9,10,11]. 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 [12,13].

Preliminary research has been conducted in SMA N 1 Blambangan Umpu. The results of this preliminary study were conducted to review how the condition of creative thinking skills are performed by students. Looking at the issues in preliminary research, researchers have conducted research through 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 learning of physics not only by using formulas and questions, but it can also come into contact with the tools and everything that exists in everyday life related to physics.

1. 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, engeneering, and Mathematics (STEM) to improve students ' creative thinking skills.

This research using Quasi-Ekspriment research with the research design applied to this research is One Group Pretest-Posttest Design. Its research plan is as follows:

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | | O1 | X | O2 | |
| **Figure 1.** Design Eksperimen *One Group Pretest-Posttest Design* |

Description:

O1 = Pretest

O2 = Posttest

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 pretests and posttest on students while qualitative data was obtained by conducting interviews on students after learning. The devices used are syllabus, RPP (Learning Implementation Plan), LKPD (learners ' worksheets), learning materials, instruments about creative thinking skills, and protocol interviews.

1. Result and Discussion

Learning with STEM approaches can be combined with a variety of learning models, it is based on the research conducted by [14] which discusses the STEM approach, PjBL learning model, and STEM-PjBL On science learning. The science learning that complies with the STEM approach is one of Project-based learning models.

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

The instrument used for pretests and posttest in the implementation stage, has previously been tested in Daluhu with validity and reliability tests to determine whether or not the instrument is used and to determine the level of trust Problem. The validity test of the problem obtained 10 questions is declared valid. The number of respondents to the validity test was 14 students with α = 0.050 so that the Rtable was 0.4575. Based on the results in table 8 can be seen that 10 questions are declared valid due to the Rcount value of > rtable with α = 0.050 so the problem can be used to measure students ' creative thinking skills. 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 pretests and posttest results consisting of 10 reasoned double choice questions. The following is the result of the pretests and posttest data that the student acquired.

**Table 1.** Data on results of Pretest, posttest, and N-Gain students

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

Based on the table above, it is noted that the value of students ' creative pretests is only reaching 51 points, after the treatment using the STEM model occurs increased achievement of 20 points so that the average posttest value thinks Creative students to 73 points. 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.

|  |
| --- |
| Average value of posttests  Average value of pretests  Average value of posttests |
| **Figure 2.** Graph of average value of Pretest and Posttest students |

After being given treatment with the STEM approach there is an increase in student creative thinking skills. This can be seen based on the value 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 [15] stating that the LKS developed with the STEM approach can improve skills with N-gain value in moderate criteria, making it clear that learning with Using the STEM approach can improve students ' creative thinking skills.

|  |
| --- |
|  |
| **Figure 3.** N-gain every 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 value, it is concluded that the learning approach using the STEM approach is able to improve students ' creative thinking can also be seen in the results of the pretests and posttest responses of one of the students figure 5 and 4.

|  |
| --- |
|  |
| **Figure 4.** Pretest Student Creative Thinking results |

Figure 4 Products ' answers to students before conducting a project-based STEM approach. The results of the students ' written answers only meet the the smoothness 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 a smooth thinking (smoothness) is a 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 Pretest students can be seen that a creative thinking student is still low. After that, students study using the STEM approach given by Posttest. The results of the posttest answer can be seen from Figure 5.

|  |
| --- |
|  |
| **Figure 5.** Posttest Student Creative Thinking results |

Figure 5 is the result of posttest students after using the project-based STEM learner approach. From the picture above can be. See 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 the Pascal vessel after being given pressure on the answer sheet as a manifestation of the idea of flexibility skills that are skills 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 [16] 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 pretests and posttest data normality tests are visible in the following table.

**Table 2.** Test results The normality of creative thinking skills

|  |  |  |
| --- | --- | --- |
| **Aspect** | ***Sig*** | **Category** |
| *Pretest* | 0,088 | Normal |
| *Posttest* | 0,173 | Normal |

Data of normality test results shows that the significance value in the pretests sig data. (0.088) > α (0.050) and posttest sig. (0.173) > α (0.050), so it can be concluded that both data are of normal distribution.

Test Paired samples of T-tests were conducted to determine whether or not the average increase in the creative thinking skills of students before and after the STEM approach was established. The following test results Paired T-test samples that have been done.

**Table 3.** Test result *Paired sample T-test*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ***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% with a value of SIG. (0.00) < α 0.05 then H0 means rejected and H1 accepted, so it can be concluded that there is a change before and after implementing a stem approach with -oriented project-based learning to improve creative thinking skills.

Based on the results of interviews with students that learning using the STEM approach can make students easier to understand the material presented and get the phenomenon that occurs in daily life. This is in line with the opinion of [17] stating that STEM is capable of enhancing the mastery of knowledge and phenomenon occurring in the environment.

1. Conclusion

Based on results and discussion, it is concluded that learning with a rod approach can improve creative thinking on students in a signified level with HU 95% and improved Lot indicators of creative thinking skills Different. The indicator of a creative thinking included category of moderate fasgations, originality, elaboration, and evaluation while included in the level category is flexibility.

**Acknowledgement**

First of all, the author would like to thank to the educational institution, University of Lampung. Secondly, the author would like to thank to the schools that have allowed to do research. Thirdly, the authors would like to thank to the experts as reviewers for some comment and suggestion to make the paper better.

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