Advances in Social Science, Education and Humanities Research, volume 611
International Conference on Educational Studies in Mathematics (ICoESM 2021)

The Effectiveness of Integrated Project-Based Learning (PjBL) Model with STEAM in Learning Mathematics

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ABSTRACT
This thesis aims to know the effectiveness of the Integrated Project Based Learning (PjBL) Model with STEAM in learning mathematics. This research was done in the Junior High School of Unismuh Makassar. This research used pre-experimental and pre-experimental. The one group pre-test post-test was done within 3 meetings. The data collecting technique was testing, students' activity observation, students' response questionnaire, and documentation. The sampling of this research was the students of VII.B2 grade of Junior High School of Unismuh of Makassar consisted of 30 students. The result of the study was obtained from the indicators of students' exhaustiveness showed that the classical test individually 100 % there was not a student who had upper score then KKM. While in post-test classically, there were 23 students or 76,67% who passed from the based minimum score (KKM), and there were 7 students or 23,33% who did not pass in getting a minimum score. The students' response toward the approach can increase to 87,88%, and the students' activity in the learning process by implementing the Integrated Project Based Learning (PjBL) Model with STEAM was good. Based on the result of the research, we can conclude that the learning process of Mathematics used Integrated Project Based Learning (PjBL) Model with a STEAM of Grade VII.B2 of Unismuh Junior High School grade VII.B2 were effective based on the students' learning score was improved, the students' response was positive, and the students' activity was good.

Keywords: *Learning Mathematics, Project Based Learning, STEAM.*

1. INTRODUCTION

Technology is the main factor for the progress and development of a country. The advancement of science and technology must be accompanied by the human ability to master science and technology, including mastery of the underlying science.

One of these sciences is Mathematics. Mathematics is the basis for the development of modern science and technology, advancing human thinking and analysis. Mathematics has a significant role in life. So that mathematics lessons in schools become a priority in educational development. It is stated in the curriculum that teaching mathematics in schools is primarily aimed at preparing students to face a dynamic world change that emphasizes logical, rational (rational), and critical reasoning, as well as providing them with skills to be able to use mathematics and mathematical reasoning in solving various problems in everyday life and in studying other fields of science [1].

Despite teaching mathematics in life, it is essential that mathematics learning is not fully responded to positively by students. Some students find learning mathematics difficult. Likewise, in teaching and learning, some students are not too active in participating in mathematics learning. As in the interview the researcher had conducted with the seventh-grade mathematics teacher at SMP Unismuh Makassar. He explained that in learning mathematics, students sometimes have difficulty understanding the concepts of the material described. This can be seen from student learning outcomes and can be seen when learning takes place. Not many students actively respond to teachers during learning, even

though teachers often ask questions if something is unclear or poorly understood. Furthermore,

Based on the problems above, it is necessary to have a learning model that makes students understand mathematics learning and actively participate in the learning process. One of the learning models in question is the project-based learning (PjBL) model. This PjBL model emphasizes contextual learning through complex activities such as giving students the freedom to explore, plan learning activities, carry out collaborative projects and ultimately produce a product.

Considering that the learning process with the PjBL model emphasizes contextual learning related to everyday life and focuses on projects, it is very suitable if it is combined with the STEAM (Science, Technology, Engineering, Arts and Mathematics) approach in addition to supporting students in solving problems in everyday life. Complex, the STEAM approach also integrates various disciplines. Henriksen [2] states that STEAM has a view that focuses on several principles, namely: interdisciplinary, creativity, factual learning, and project-centered thinking. Buinicontro [3] defines STEAM as integrating the arts disciplines into the curriculum and learning in science, technology, engineering, and mathematics, previously known as (STEM).

This study will discuss how the effectiveness of learning mathematics through the integrated PjBL (Project Based Learning) learning model (Science, Technology, Engineering, Arts, and Mathematics) will be discussed. How learning outcomes, learning implementation, activities, and student responses are after implementing the PjBL (Project Based Learning) integrated STEAM (Science, Technology, Engineering, Arts and Mathematics) learning model.

Table 1. Results of Observation of Learning Implementation through the STEAM integrated PjBL learning model

Meeting	Average score	Classification	Criteria
I	3.59	$3.00 < 4.00\overline{X}$	Very good
II	3.65	$3.00 < 4.00\overline{X}$	Very good
III	3.71	$3.00 < 4.00\overline{X}$	Very good
Average	**3.65**	**$3.00 < 4.00\overline{X}$**	**Very good**

2. METHOD

This research is a pre-experimental study involving one class as an experimental class with One Group Pretest-Posttest Design research design. This design performs two measurements, namely before treatment (pretest) and after treatment (posttest). In this study, one experimental class was used, namely class VII B2 SMP Unismuh Makassar.

The instruments used in this study were learning outcomes tests, observation sheets, and student response questionnaires. Learning outcomes tests are used to obtain student learning outcomes after implementing the integrated PjBL (Project Based Learning) learning model (Science, Technology, Engineering, Arts, and Mathematics). The instrument used is a test based on learning objectives. The test given to students is in the form of essay questions. Scoring student test results using a free scale that depends on the weight of the item. Two observation sheets are student activity observation sheets, used to obtain data about student activities while participating in learning, and learning implementation observation sheets to get data about how well learning is implemented when learning is carried out. The items of this instrument refer to the learning steps through the STEAM integrated PjBL learning model adapted into the lesson plans. Student response questionnaires were used to determine student responses to mathematics learning.

After the instrument is validated, the experimental class is carried out direct observation or observation. Before learning, students were given pretest questions to see the students' initial abilities. Then students were taught using the STEAM integrated PjBL learning model. At the end of the lesson, students were given posttest questions.

Data analysis in this study is to use Descriptive Statistical Analysis and Inferential Statistical Analysis.

3. RESULTS AND DISCUSSION

The results of this study indicate a description of the effectiveness of the application of the STEAM integrated PjBL learning model in mathematics learning which includes (1) the implementation of mathematics learning, (2) student learning outcomes, (3) student activities, (4) student's responses.

The implementation of learning through the application of the STEAM integrated PjBL learning model is described as follows:

Based on Table 1, it can be seen that at the first meeting, the average score was 3.59, at the second meeting, there was an increase of 3.65, and at

the third meeting, an increase of 3.71 again. So it can be concluded that implementation of learning overall performed very well with an average of 3.65. According to the criteria for the effectiveness of the implementation of learning with the STEAM integrated PjBL learning model, it can be said to be effective if the implementation of learning has reached very good criteria.

Description of Student Mathematics Learning Outcomes, namely the average pretest score for class VII B2 SMP Unismuh Makassar students is21.51 of the ideal score of 100 that students may achieve with a standard deviation of 4.34, which means that the average value is greater than the standard deviation so that it can be said that the average value is increasingly representative of the data and has a varied distribution of data. The average posttest score for class VII B2 SMP Unismuh Makassar students is 81.82 from the ideal score of 100 that students have achieved with a standard deviation of 12.96, which means the standard deviation is lower than the average score so that it can be said that the distribution of data on the average sample is the same.

Description of Student Activity Observation Results with the PjBL integrated STEAM learning model for 3 meetings that the indicator of the success of student activities in this research is indicated by at least 75% of students being actively involved in the learning process, while the average percentage of student activity is 89.18%

In general, the average student of class VII B2 SMP Unismuh Makassar responded positively to the implementation of learning through the STEAM integrated PjBL learning model, where the average percentage of students' positive responses is 87.88%. Thus, the student response can be effective because it has met the student response criteria, namely:75 %, which gives a positive response.

3.1. Normality Test

The normality test aims to determine whether the average score of student learning outcomes (pretest-posttest) is normally distributed. The test criteria are:

If P-value = 0.05 then the distribution is normal.

If P-value < = 0.05 then the distribution is not normal.

Using the help of a computer program with the Statistical Product and Service Solutions (SPSS) program with the Kolmogorov-Smirnov Test. The analysis results of the average score for the pretest showed a P-value > which was 0.136 > 0.05, and the average score for the posttest showed a P-value > 0.139 > 0.05. This indicates a difference between the pretest score and the posttest score with a normal distribution.

3.2. Gain Test

Normalized gain testing aims to determine how to complete student learning outcomes. The results of the Normalized gain test, which can be seen in the appendix, show that the gain index = 0.77. This means that at the g interval of 0.7, it can be concluded that the increase in learning outcomes is categorized as high.

3.3. Hypothesis Testing

The hypothesis test was analyzed using the t-test. The average student learning outcomes after being taught using the STEAM integrated PjBL learning model were calculated using the one-sample test t-test, which was formulated with the following hypothesis:

H0 : 74.9 against H1 : > 74.9

Information:

μ: The average score of student learning outcomes

Based on the results of the SPSS analysis (attachment), it appears that the p-value (sig. (2-tailed)) is 0.000 < 0.05 indicating that the average student learning outcomes after being taught through the STEAM integrated PjBL learning model is more than 75. This means that H0 is rejected and H1 is accepted, i.e., the average post-test learning outcomes are more than or equal to the KKM.

Students' learning mastery after being taught using the PjBL integrated STEAM learning model is classically calculated using the proportion test, which is formulated with the following hypothesis:

H0 : 74.9 % against H1 : > 74.9 %π π

Information:

π: Parameters of classical learning completeness

Classical completeness testing of students is done by using the proportion test. For the proportion test using a significant level of 5%, Z table = 0.087 means that H0 is accepted if Z count < 0.087. Because the value of Z count = 0.22, H0 is rejected, meaning that the proportion of students who reach the completeness criteria of 75 (KKM) > 74.9% of all students who take the test. Based on the description above, it can be seen that the proportion of students who reach the

completeness criteria of 75 (KKM) is more than 74.9%. So it can be concluded that inferentially students' mathematics learning outcomes after being taught using the STEAM integrated PjBL learning model meet the effectiveness criteria.

The average normalized gain of students after being taught using the STEAM integrated PjBL learning model is calculated using the one-sample t-test, which is formulated with the following hypothesis:

H0 : g 0.29 against H1 : g > 0.29

Information:

μ_g: Average score of normalized gain

Based on the results of the analysis, it appears that the value of p (sig. (2-tailed)) is 0.000 <0.05 indicating that the average normalized gain in-class students is more than 0.29. This means thatH0 is rejected and H1 is accepted, i.e., the normalized gain of student learning outcomes is in the medium category.

From the analysis above, it can be concluded that the average score of student learning outcomes after learning through using the STEAM integrated PjBL learning model has met the effectiveness criteria.

4. RESEARCH RESULTS

The analysis results described in the previous section show that STEAM integrated PjBL learning model in-class students VII B2 SMP Unismuh Makassar can improve students' mathematics learning outcomes. Furthermore, the discussion of research results will be described, including a meeting of the results of descriptive analysis and a discussion of the results of the inferential analysis.

Discussion of the results of descriptive statistical analysis on (a) student learning outcomes, (b) student activities in mathematics learning through the STEAM integrated PjBL learning model, (c) Student responses to mathematics learning through the STEAM integrated PjBL learning model, and (d) Mathematics learning implementation through the STEAM integrated PjBL learning model.

The results of the data analysis of student learning outcomes before applying mathematics learning through the STEAM integrated PjBL learning model showed that there were 30 students or 100% of the total 30 students, who did not achieve individual completeness (getting an achievement score below 75), in other words, student learning outcomes before the implementation of the integrated PjBL learning model, STEAM was very low and did not meet the criteria for classical completeness.

The data analysis of student learning outcomes after applying mathematics learning through the STEAM integrated PjBL learning model showed that 77.27% achieved individual mastery (minimum score of 75). In comparison, students who did not reach minimum completeness or individual were 22.73%. This means that classical student learning completeness has been achieved.

The results of observing student activities in mathematics learning through the STEAM integrated PjBL learning model in class VII B2 SMP Unismuh Makassar show that they have met the active criteria. However, according to the student activity indicators, student activities are successful/effective if at least 75% of students are actively involved in the learning process. From the analysis of observational data on student activity, the average percentage of the frequency of student activity with learning through the STEAM integrated PjBL learning model is 89.18% of student activity in each meeting. It can be concluded that students have actively participated in the mathematics learning process by applying the STEAM integrated PjBL learning model.

From the results of the analysis of student responses, it was found that 87.88% of students gave a positive response to the implementation of mathematics learning through the application of the STEAM integrated PjBL learning model. The analysis results show that learning through the STEAM integrated PjBL learning model has achieved effectiveness indicators used as benchmarks, with a positive response of at least 75% of all respondents.

This means that learning mathematics by applying the STEAM integrated PjBL learning model can change students' views of difficult and boring mathematics towards fun mathematics so that the desire to learn mathematics is greater.

Based on the results of research observations, it can be seen that in implementation of learning who use the integrated PjBL learning model STEAM Educators do well in learning it can be seen at the first meeting the average score was 3.59, at the second meeting there was an increase of 3.65. At the third meeting, it again increased by 3.71. So it can be concluded that implementation of learning overall very well done. This is indicated by the average score implementation of learning from the first to the third meeting of 3.65. According to the criteria for the effectiveness of the implementation of learning with the STEAM integrated PjBL learning model, it can be

said to be effective if the implementation of learning has reached very good criteria.

According to the effectiveness criteria, implementation of learning is said to be effective if it reaches good criteria. So it can be concluded that implementation of learning with the integrated PjBL learning model STEAM is effective.

Thus, the results of data analysis show that the implementation of learning is in the category of very well done, students' mathematics learning outcomes are classically completed, student activities reach the criteria, and student responses to the learning process through the positive STEAM integrated PjBL learning model. Based on this, learning is said to be effective because of the effectiveness indicators (student learning outcomes, student activities, and student responses to the learning process) and the fulfillment of learning implementation. It can be concluded that "Mathematics learning is effective by applying the STEAM integrated PjBL learning model in class VII B2 SMP Unismuh Makassar".

The results of inferential statistical analysis are intended to discuss the results of hypothesis testing formulated previously. The results of the inferential analysis show that the average score of student learning outcomes after learning through the application of the STEAM integrated PjBL learning model shows that the p-value (sig. (2-tailed)) is 0.000 <0.05 indicating that the average student learning outcomes after being taught through the STEAM integrated PjBL learning model more than 75. This means thatH0 is rejected and H1 is accepted, i.ethe average posttest learning outcomes of class students are more than or equal to the KKM. After being taught with the classical STEAM integrated PjBL learning model, the mastery of student learning is more than 74.9%. So, it can be concluded that the classical mastery of students after being taught by applying the STEAM integrated PjBL learning model is more than 74.9%.

From the results of the descriptive and inferential analysis obtained, it turns out that it is quite supportive of the theory that has been put forward in the literature review. Thus it can be concluded that "Mathematics learning is effective by applying the STEAM integrated PjBL learning model in Class VII B2 SMP Unismuh Makassar".

5. CONCLUSION

Based on the results of data analysis and discussion, it can be concluded that "mathematical learning is effective through the integrated PjBL (Project Based Learning) learning model (Science, Technology, Engineering, Arts and Mathematics).

ACKNOWLEDGMENTS

The author would like to thank both parents who have educated the author with love. The author also thanks to the teachers and lecturers who provided knowledge to the author to finish this article well. Likewise, the Unismuh Makassar Junior High School has allowed the author to research the school.

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