The Effects of Implementation Project Based Learning Model Base on Student's Critical Thinking Skills at Vocational Secondary Schools 1 Polewali Mandar

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ABSTRACT

This study is a quantitative study that aims to determine the effect of project-based learning models on students' critical thinking skills in terms of national exam scores. This study used a quasi-experimental method with a pretest-posttest control group design. The population and sample of the study were all students of class X in vocational secondary schools 1 Polewali Mandar with a total sample of 70 people. This research data is in the form of documentation of national exam scores and students' mathematical critical thinking ability test results. The results of this study are (1) the mathematical critical thinking ability of students who are treated with project-based learning models is higher than students who are treated with conventional learning. (2) There is an influence between test scores on students' mathematical critical thinking abilities. (3) There is an interaction between the learning models on students' mathematical critical thinking skills in terms of national exam scores

Keywords: *Influence, Mathematical Critical Thinking Ability, Project Based Learning Model, National Test Scores.*

1. INTRODUCTION

Mathematics is one of the fields of study that occupies an essential role in education. This can be seen from the time of school hours more than other subjects. Mathematical critical thinking is the basis of the thinking process to analyze arguments and generate ideas for each meaning to develop a logical mindset. Noer also expressed in [1] that critical mathematical thinking is a process that leads to concluding what we should believe and the actions to be taken.

Based on the results of an interview with one of the mathematics teachers at SMK Negeri 1 Polewali, it was stated that students' National Mathematics Examination scores were still low compared to other subjects. This can be seen in the following table1.

In addition, most of the students' math scores have not reached the Minimum Completeness Criteria (KKM) for subjects set by the school. Students' classical mastery of certain materials has not reached 85%.

Table 1. National Examination Scores for SMKN 1 Polewali Students in 2017

Subjects	National Exam Score
Indonesian	60.03
English	35.72
Mathematics	28.46
Vocational	72.11

Source: [2]

Students' critical thinking skills are also still weak due to several factors. One of the contributing factors is the learning process that has not maximized the active involvement of students to use their critical thinking skills. This is in line with what Johnson said in a study conducted by [3] that if students are allowed to practice their thinking skills, habits will form to distinguish between true and false, conjecture and reality, facts and

opinions, and knowledge and beliefs. In addition, students will naturally think creatively.

Therefore, a learning model is needed that can activate students to improve their mathematical thinking skills. One of the learning models that are expected to overcome these problems is Project-Based Learning. The focus of PjBL lies in the core concepts and principles of a discipline of study, involving students in problem-solving investigations and other meaningful task activities, providing opportunities for students to work autonomously to construct their knowledge, and culminating it in real products. PjBL is innovative learning that emphasizes contextual learning through complex activities [4].

The results showed that the percentage increase in conventional learning in the control class experienced an increase in critical thinking skills of 27.4%. In comparison, the increase in critical thinking skills in project learning in the experimental class was 61.8%. This means that based on the corrected mean comparison, the experimental class has 34.4% higher critical thinking ability than the control class [5].

The existence of problems as above, the writer is interested in conducting a research entitled " The Effects Implementation Project Based Learning Model Base On Student's Critical Thinking Skills at Vocational Secondary Schools 1 Polewali Mandar".

2. LITERATURE REVIEW

2.1. *Project-Based Learning Model*

Project-based learning is defined as teaching that links technology with everyday problems familiar to students or school projects. Thus, this learning is also close to activities and daily life issues that are the topic of student project assignments [6].

Project-Based Learning (PjBL) is innovative project-based learning, which emphasizes contextual learning through complex activities. *Project-based learning* is active learning by involving students independently, which will increase students' thinking power towards metacognition, such as critical thinking about projects that will be worked on through problems found by students. This *project-based learning* is authentic, so indirectly, this learning will involve the learner in constructive investigation [5]. Basic Learning projects generally have a guideline of steps: Planning, Creating, and Processing [4].

The learning steps in the *project-based learning* model by The George Lucas Education Foundation (George Lucas, 2005) consist of:
a.   Start with the essential question.

b.   Planning of project work rules.
c.   Create a schedule of activities.
d.   Monitoring the progress of student projects.
e.   Assessment of student work.
f.   Evaluation of students' learning experiences.

Based on the explanation about *project-based learning* above, it can be concluded that the project-based learning model is a learning design, which transfers knowledge and skills through project assignments related to student life so that it is easy to understand. The project assignment obtains the final result in the form of a product or student work.

2.2. *Critical Thinking Ability*

Critical thinking can prepare students to think in various disciplines and can be used to meet intellectual needs and develop students' potential. Critical thinking is an important skill because it prevents people from making bad decisions and helps them solve problems, but it is not an easy skill to develop or use [7].

Critical thinking skills consist of six cognitive skills [8].

a.   Interruption
b.   Analysis
c.   Evaluation
d.   Explanation
e.   Self Regulation

Based on the explanation, the indicators used in this study take several indicators of Facione's opinion, namely: Interpretation, analysis, explanation, and conclusion.

Mathematical critical thinking ability is an effective thinking skill that can help someone make, evaluate, and decide what to believe or do.

2.3. *National Exam*

The National Examination (UN) is an assessment of learning outcomes by the government which aims to assess the achievement of graduate competencies nationally in certain subjects in the science and technology group [9].

3. RESEARCH METHOD

3.1. *Location*

The location of the research was carried out at SMK Negeri 1 Polewali Mandar on Jln. Kyai Haji Agus Salim, Darma Village, Polewali Mandar Regency, West Sulawesi Province.

3.2. Research Type and Design

3.2.1. Types of research

This research includes correlational research with a quantitative approach that aims to determine the effect of the Project-Based Learning model on students' mathematical critical thinking skills in terms of national exam scores.

3.2.2. Research design

The research design uses a pre-test/post-test control group, which is presented in table 3.2.2

Table 2. Research Design

Group	Pretest	Treatment (independent variable)	Posttest (Dependent variable)
E (Experiment)	Y	X	Y_1
C (Control)	Y	-	Y_1

Information:
Y = Pretest
X = Project based learning model
Y_1 =Posttest

3.3. Population and Sample

The population in this study were all students of class X SMK Negeri 1 Polewali Mandar, totaling 394 students. The sample selection was conducted by random sampling with a total of 70 students.

The variables in this study are students' mathematical critical thinking skills and students' national exam scores. The mathematical critical thinking ability in question is the score obtained by students from the mathematical critical thinking ability test before and after learning mathematics. The National Examination scores in question are the scores obtained by students from the previous national examinations (SMP).

3.4. Research Instruments

The research instruments used in the research are:

1. The test is seen from the pre-test and post-test questions.
   a. The pre-test is a test used to collect initial data related to student learning outcomes and to see the similarity of initial abilities in students.
   b. A post-test is a test used to see students' critical thinking skills measured using a performance appraisal. The indicators that become the criteria for critical thinking

skills in this test are 1). Interpretation, 2). Analysis, 3). Explanation, 4). Conclusion.

2. Documentation is seen from the students' UN scores which consist of High, Medium, and Low. The steps in determining the three categories (Setiawati, 2017) are as follows:
   a. Summing up the UN scores of all students.
   b. Finding the mean (Mean) and standard deviation (Standard Deviation)

$$mean = \frac{\Sigma x}{N}$$

Information:
Σx = total score
N = number of students

$$SD = \sqrt{\frac{\Sigma x^2}{N} - \left(\frac{\Sigma x}{N}\right)^2}$$

Information:
SD = Standard Deviation
$\frac{\Sigma x^2}{N}$ = the number of scores that have been squared, then divided by N
$\left(\frac{\Sigma x}{N}\right)^2$ = the number of scores squared, then divided by N

   c. Define group boundaries.
   UN Value tall : $x \geq mean + SD$
   UN Value currently : $mean - SD < x < mean + SD$
   UN Value low : $x \leq mean - SD$

3.5. Data Collection Technique

The collection is done by giving instruments to students who are research samples. The author carried out this data collection. This data collection was carried out in stages according to the research plan and schedule. Data collection techniques in this study were carried out using:

3.5.1. Test

In this study, the test method was used to determine the improvement of students' critical thinking skills in mathematics learning that applied and did not apply the Project-Based Learning model. The test used is in the form of an essay consisting of 5 questions.

3.5.2. Documentation

In this study, the documentation technique was used to determine the students' initial and abilities during the learning process. The data was collected in the national exam scores of students at the junior high school (SMP) level.

4. RESULTS AND DISCUSSION

4.1. Research Result

In this study, the first action was to give a pretest mathematics learning outcome test in the experimental and control classes. Furthermore, the provision of the act applies the Project-Based Learning model to the experimental class. After the action was carried out in the experimental and control classes, the mathematics learning outcomes test was given after the post-test in the experimental and control classes, which was seen from the students' mathematical critical thinking abilities in terms of the National Examination scores.

Table 3. Statistics of learning outcomes Pretest experimental class and control class

Statistics		Experiment	Control
N	Valid	35	35
	Missing	0	0
mean		69,620	67.212
Std. Error of Mean		1.7935	1.4158
median		68,420	68,420
Mode		68.4	68.4
Std. Deviation		10.6108	8.3760
Variance		112,589	70.158
Range		36.9	26.3
Minimum		47.4	52.6
Maximum		84.2	78.9
Sum		2436.7	2352.4

Table 4. Completeness of Learning Pretest Critical Thinking Ability of Students

No	Mark	Criteria	Experiment F	Experiment %	Control F	Control %
1	75 – 100	Complete	24	68.58%	6	17.14%
2	0 – 75	Not Complete	11	31.42%	29	82.86%

Based on Table 3, it can be seen that the mathematics pretest score on the material relations and functions of students in the experimental class obtained the highest score of 84.2 and the lowest score of 47.4. As for the average score of 69.62 with a standard deviation of 10.61 and a variance of 112.5. while the pretest score of students in the control class obtained the highest score of 78.9 and the lowest score of 52.6. the mean score is 67.21 with a standard deviation of 8.37 and a variance of 70.15.

Based on Table 4, it can be seen that from all students, the initial test scores for critical thinking skills in the experimental class were 24 people in the complete

category and 11 people in the incomplete category. Meanwhile, 6 people were in the complete category of critical thinking skills in the control class, and 29 people were in the incomplete category.

Table 5. Statistics of posttest learning outcomes for experimental class and control class Statistics

		Experiment	Control
N	Valid	35	35
	Missing	0	0
mean		82.180	73.945
Std. Error of Mean		1.5009	1.9222
median		82,350	70,580
Mode		76.5a	70.6a
Std. Deviation		8.8793	11.3716
Variance		78,842	129,314
Range		38.2	41.2
Minimum		61.8	52.9
Maximum		100.0	94.1
Sum		2876.3	2588.1

a. Multiple modes exist. The smallest value is shown
Source: 2019 data analysis results

Based on Table 5, it can be seen that the Mathematics posttest scores on the material relations and functions of students in the experimental class obtained the highest score of 100 and the lowest score of 61.8. As for the average score 82.18 with a standard deviation of 8.87 and a variance of 78.84. while the pretest score of students in the control class obtained the highest score of 94.1 and the lowest score of 52.9. the mean score is 73.94, with a standard deviation of 11.37 and a variance of 129.31.

Table 6. Posttest Learning Completeness of Students' Critical Thinking Ability

NO	Mark	Criteria	Experiment F	Experiment %	Control F	Control %
1	75 – 100	Complete	28	80%	18	51.42%
2	0 – 75	Not Complete	7	20%	17	48.58%

Based on Table 6, it can be seen that from all students, the initial test scores for critical thinking skills in the experimental class were 28 people in the complete category and 7 people in the incomplete category.

Meanwhile, in the control class for the initial critical thinking skills test, 18 people were in a complete category, and 17 people were in the incomplete category.

Table 7. Number of Students for Each Category of National Examination Scores

Class	National Exam Score Category		
	Tall	Currently	Low
Experiment	5	25	5
Control	6	23	6

Source: UN Value Documentation

Based on Table 7, it can be seen that the national exam scores in the experimental class that obtained the highest score were 5 people. The average score was 25 people. The low score was 5 people, while in the control class, the students who got the highest score were 6 people, the average score was 24 people, and the low 6 people.
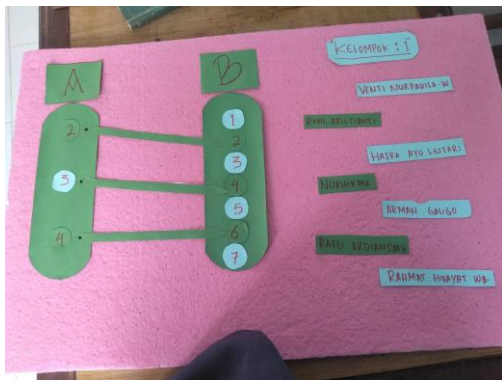

Figure 1. The work of *Project-Based Learning*

The picture above is an example of students in the experimental class who were treated with the project-based learning model.

Table 8. Results of Assessment of Project-Based Learning Worksheets

No	Group name	Score
1	Group 1	16
2	Group 2	18
3	Group 3	15
4	Group 4	13

Based on Table 8, it can be seen that the project assignments given to each group have different results,

Group 1 with a score of 16, group 2 with a score of 18, group 3 with a score of 15, and group 4 with a score of 13. This can be seen from the Project-Based assessment. Learning that has 4 assessment rubrics with a maximum score of 20, including 1). Performance with a maximum score of 5 and a minimum score of 0.2). Work Steps and work safety with a maximum score of 5 and a minimum score of 0, 3). Punctuality of practice with a maximum score of 5 and a minimum score of 0, 4). Teamwork in practice with a maximum score of 5 and a minimum score of 0.

4.2. Discussion

Many factors can influence students' mathematics learning outcomes. This study examines the effect of applying the project-based learning model on students' critical thinking skills at SMK Negeri 1 Polewali Mandar. The normal test for the residual variable by looking at the significant value is that the data comes from a normally distributed population. There are significant differences in variance from several tests conducted on the independent and dependent variables. This means that two-way ANOVA can be used as a hypothesis testing tool.

Based on the first hypothesis test results using two-way ANOVA, there are differences in students' mathematical critical thinking abilities between the experimental and control classes. Looking at the marginal average results between students' mathematical critical thinking ability test results that were applied to the Proj*ect-Based Learning* model, it was obtained 243.04, and the students' mathematical critical thinking ability test results that were not applied to the *Project-Based Learning* model was 206.08. It can be seen that the mathematical critical thinking ability applied by the *Project-Based Learning* model is higher than the mathematical critical thinking ability that does not apply the Project-Based Learning model.

Based on the second hypothesis test results, national exam scores have an effect on students' critical thinking skills. This can be seen from the results of the multiple comparison test based on the marginal mean, the results of the mathematical critical thinking ability of students who have a high national exam score of 148.52, while the results of students' mathematical critical thinking skills who have a medium national exam score of 161.2 and a low national exam score of 139.4. This shows that students' mathematical critical thinking skills with average national exam scores are higher than those with high and low national exam scores.

From the results of the multiple comparison test, the following conclusions are obtained:
1. There are differences in the mathematical critical thinking ability of students with high national exam scores who apply the *Project-Based Learning* model to those that do not apply the *Project-Based Learning*

model. By looking at the marginal average, it can be concluded that students with high national exam scores who apply the *Project-Based Learning* model are better than those who do not apply the Project-Based Learning model.

2. There are differences in students' mathematical critical thinking skills with average national exam scores applied to the *Project-Based Learning* model and those not applied to the *Project-Based Learning* model. By looking at the marginal mean, it can be concluded that students with average national exam scores who apply the Project-Based Learning model are better than those who do not apply the *Project-Based Learning* model.

3. There are differences in the mathematical critical thinking ability of students with low national exam scores who apply the *Project-Based Learning* model to those that do not apply the *Project-Based Learning* model. By looking at the marginal mean, it can be concluded that students with low national exam scores who apply the Project-Based Learning model are better than those who do not apply the *Project-Based Learning* model.

Based on the tests that have been done previously, it is clear that students in the experimental class have good mathematical critical thinking skills compared to the control class. The students' pretest learning completeness can prove this wherein in the experimental class, 24 people are complete, and 11 people are incomplete, while the control class has 6 people who are complete and 29 who are not. Shows the students' posttest learning completeness, where the experimental class has 28 people who have completed and 7 incomplete people, while the control class has 18 people who complete and 17 who don't.

From the results of the inferential analysis of the ANOVA test for the posttest results, it can be concluded that: 1). $F_{count} \geq F_{table}$, namely $8,573 \geq 3,145$ with a sig level of $0,001 \leq 0,05$ then H_{1A} it is accepted so it can be concluded that there are differences between the Project-Based Learning to model the conventional model on students' mathematical critical thinking skills. 2). $F_{count} \geq F_{table}$, namely $19,956 \geq 3,995$ with a sig level of $0,000 \leq 0,05$ then H_{1B} it is accepted so it can be concluded that national exam scores on students' mathematical critical thinking skills. 3). $F_{count} \geq F_{table}$, namely $3,475 \geq 3,145$ with a sig level of $0,037 \leq 0,05$ then H_{1AB} it is accepted so it can be concluded that there is an interaction between learning models on students' mathematical critical thinking skills in terms of national exam scores.

The difference in the mathematical critical thinking ability of students who apply the Project-Based Learning model is better than that of students who do not use the Project-Based Learning model. Students who have average national exam scores do better than students with high and low national exam scores.

5. CONCLUSION

Based on the research results, it can be concluded that there is an effect of implementing the Project-Based Learning model on the mathematical critical thinking skills of class X SMK 1 Polewali in terms of national exam scores. This can be seen from the class that applies the *Project-Based Learning* model to students' mathematical critical thinking skills, which are seen from each category of national exam scores better than those who do not apply the *Project-Based Learning* model to students' mathematical critical thinking abilities in terms of each. -each category of national exam scores.

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