



Project Based Blended Learning Model with Moodle Application to Enhance Students Mathematical Critical Thinking Ability

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Abstract. One of the mathematical competencies that students should possess is mathematical critical thinking ability. However, the outcomes they achieve are not as expected. This could be because the online learning carried out during Covid-19 has not gone well. The purpose of this study is to ascertain whether a project-based blended learning approach using the Moodle application improves students' mathematical critical thinking skills better than conventional learning. This study is a quasi-experimental study with a sample of 57 students made up of 29 students in the control group and 28 students in the experimental group. A test of mathematical critical thinking skills was included in the research instrument. The t-test was utilized in the statistical analysis of the data. The Finding of this study indicated that mathematical critical thinking ability of students using project-based blended learning model with Moodle application were better than mathematical critical thinking ability of students with conventional learning model.

Keywords: Project Based Blended Learning, Moodle Application, Mathematical critical thinking ability.

1 Introduction

The 21st century is the beginning of the third millennium which is marked by the advancement of science knowledge of information and communication technology. One of the abilities that must be mastered by students in the 21st century is critical thinking ability[1]–[3]. Critical thinking is defined as the ability to consider various information obtained from various different sources, then process them creatively and logically and analyze them to draw the appropriate conclusions [4]–[6]. Students who study mathematics need not only skills calculating but also requires skills to think and reason mathematically in solving problems and draw appropriate conclusions [5], [7]–[9]. In solving mathematical problems, critical thinking skills are needed because students must analyze coherently and specifically to a problem, distinguish problems carefully and thorough, as well as identifying and analyzing the information needed to

planning strategies to solve problems and take the right conclusion. So that in learning mathematics students are needed to have mathematical critical thinking ability.

Facion Reveals the main critical thinking involved in the process of critical thinking [4], [10]: (1) Interpretation, the ability to understand and determine problems diligently, such as making known and asking what is presented, (2) Analysis, namely the ability to identify and write down the relationship between statements, questions, and the concepts given in the problem by making a mathematical model correctly and providing clear explanations, (3) Evaluate, namely the ability to answer and complete questions completely and correctly in carrying out calculations by using the right strategy, (4) Inference, namely the ability to state the results of thoughts based on the results of solving the problems presented (5) Explaining, the ability to explain or express reasoning based on evidence, methodology and context in various forms of argument and (6) Self-Regulation, how did they arrive at conclusions that have been reached in inference [11].

However previous studies have found that the mathematical critical thinking ability was not in accordance with what was expected. Students' performance in solving problems has not shown adequate mathematical critical thinking skills [12]. Based on the results of students' daily tests in class VIII SMP N 1 Sungai Tarab, students were not fully able to interpret the information from the problem. Thus, connecting problems to mathematical models became less precise, as a result students solved problems with the wrong strategy and got wrong answers and conclusions. The low ability to think critically needs to be pursued an appropriate learning model that can improve students' critical thinking ability. Previous study showed that the learning models positively affected the mathematical critical thinking skill of students [13]. One way that teachers can do is to create a comfortable and interesting learning atmosphere because one of that affects mathematical critical thinking is the learning model used.

From the beginning of 2020, schools in Indonesia have implemented learning from home because of pandemic. However, students have various difficulties in adapting to this new way of learning[14]. Online learning greatly influenced student interest in learning. One of the reasons is that students feel unhappy because they don't meet each other directly[15]. But the Minister of Education has corrected the bad impact by allowing students to study in schools by applying blended learning. The Project Based Blended Learning model can be used by teachers as an alternative to improve students' mathematical critical thinking skills[16]. Based on the result of previous study, The project-based learning model can improve students' mathematical critical thinking skills[17]. Likewise blended learning model also can improve students' mathematical critical thinking skills[18].

The project-based blended learning model is a combination of project-based learning models with blended learning models with offline learning processes in the classroom and online learning processes at home. The general idea behind project-based learning and blended learning is to give students the opportunity to actively construct information while also helping them to develop other crucial abilities like communication, cooperation, and critical thinking through the use of contextual reality[19]. This model can be also integrated with an application such as Moodle. Moodle, also known as the Modulator Object-Oriented Dynamic Learning Environment

(MOODLE), is a learning management system (LMS) application with a number of helpful features that is suitable for the current learning needs and enables students to interact with their teachers for collaborative purposes in online activities[19], [20].

Based on the explanations, the objective of this research is to determine whether students' mathematical critical thinking ability using a project-based blended learning model with Moodle applications are better than conventional learning.

2 Methods

This study is quasi experiment that used control class and experimental class. The population of this study were students of class VIII school year in 2021/2022 SMP Negeri 1 Sungai Tarab which consist of four classes. This study used a random sampling method for its sampling process. As the experimental class and control class, two classes were chosen. There were 29 students in the control class and 28 in the experimental class. While the control class received a traditional learning approach, the experimental class received a project-based blended learning model using Moodle apps. The design of this research can be seen in table 1[21].

Table 1. The research designs

Sample	Treatment	Posttest
Experiment	X	O
Control	-	O

A test of mathematical critical thinking skills was used as the study's instrument. The normality test, homogeneity test, and hypothesis testing were used to examine the data. If the learning results have a normal distribution and the data comes from a homogeneously variable sample, then the hypothesis testing is carried out using a t-test with the formula:

$$t = \frac{(\bar{X}_1 - \bar{X}_2)}{s \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \text{ dengan } s^2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}$$

H_0 is accepted if $t < t_{\alpha(v)}$ with $v = n_1 + n_2 - 2$ besides that H_0 is rejected[22].

3 Result and Discussion

From the tests carried out on the two sample classes, the results of students' test obtained are as table 2:

Table 2. The results of mathematical critical thinking ability test

Sample	N	\bar{x}	s^2	S	Maximum	Minimum
Experiment	28	76,07	17,39	16,73	100	30
Control	29	43,96	21,81	17,94	85	10

From table 2, it can be seen that the average value between the experimental class and the control class differs. The class that used the project-based blended learning model with the Moodle Application had a higher average grade than the class that used the traditional learning model, with the experimental class receiving the highest grade. A statistical analysis was done in order to develop conclusions about the data on the test results of students' mathematical critical thinking abilities in the two sample courses. Prior to evaluating the hypothesis using the test findings from the two sample classes, the normality test and the homogeneity of variance test were conducted.

The test for normality was carried out by the Lilliefors test as in table 3.

Table 3. The results of normality test

Sample	α	N	L_0	L_{table}	Distribution
Experiment	0.05	28	0,1244	0.161	Normal
Control	0.05	29	0,1297	0.161	Normal

Based on Lilliefors test, $L_0 < L_{table}$ for both experiment and control class. Thus, it may be said that the data on mathematical critical thinking skill of students are normally distributed. Homogeneity test was analyzed by f test, as can see in table 4. Based on the F table, the value of $f_{1-\frac{\alpha}{2}}(v_1, v_2)$ is 0.4648 and the value of $f_{\frac{\alpha}{2}}(v_1, v_2)$ is 2,14. Because of $f_{1-\frac{\alpha}{2}}(v_1, v_2) < f < f_{\frac{\alpha}{2}}(v_1, v_2)$ or $0.4684 < 0,79747 < 2,14$, it can be stated that two class sample data have the same variance.

Table 4. The results of homogeneity test

Sample	\bar{x}	N	s^2	F	Conclusion
Experiment	76,071	28	17,392	0.79747	Homogenic
Control	43,965	29	21,810		

Furthermore, the t-test in both sample classes can be seen in table 5. The t-test at the level of $\alpha = 0.005$ was used to test the hypothesis.

Table 5. The t test's results

Class Sample	N	\bar{x}	t	Critical value
Experiment	28	76.071	6,982	0.79747
Control	29	43,965		

Hypothesis tested:

Ho: There is no difference in mathematical critical thinking ability between students who following project-based blended learning model with Moodle applications with conventional learning

Ha: Mathematical critical thinking abilities of students by applying the Project Based Blended Learning model with the Moodle application are better than mathematical critical thinking abilities by applying conventional learning

According to table 5, Decision-making by looking at the $t(6.982) > t \text{ table}(1.645)$ means that H_0 is rejected and H_a is accepted which means mathematical critical thinking abilities of students by applying the Project Based Blended Learning model with the Moodle application are better than mathematical critical thinking abilities by applying conventional learning.

Based on the results of this study, mathematical critical thinking abilities can be improved by applying the Project Based Blended Learning model with the Moodle application. The steps for the project-based blended learning model with Moodle [19] in this research as follows: 1) Determining basic question and finding out information. Students were stimulated to the real-world problems so that they were more active in expressing opinions. They were informed the learning objectives that will be studied, the material and an overview of the learning process that would be carried out. Then students were divided into several small groups to find information on project themes related to everyday life on face to face, then students informed plans and project themes on the Moodle application on E-Learning. 2) Designing projects, interpreting and elaborating information. Students in groups tried to design the project according to the theme obtained from the problems found according to guidance from the teacher on face to face, then students took photos of the projects and then uploaded them to the Moodle application on E-Learning. 3) Arranging schedule. Students listen to the project completion schedule given by the teacher, and students with their respective group friends also determine the project work schedule on face to face [23]. Students see the schedule of completion and progress to upload projects on the Moodle application on E-Learning. 4) Facilitating and monitoring. Students conveyed the progress of the project they were working on and students asked the teacher for help with obstacles in completing the project on face to face, then students updated project progress and mention obstacles in completing the project on the Moodle application on E-Learning. 5) Testing the results and reconstructing the knowledge. Students answered the teacher's questions about the truth of the project being made and explain the progress of the project on face to face, then students re-informed the information they got previously in the Moodle application via the Moodle application on E-Learning. 6) Evaluating. Students presented the results of group work projects to the front of the class and explained the problems on face to face, then students uploaded the results of their projects so that it can be downloaded by other students on the Moodle application on E-Learning.

Project-based learning and blended learning methods can trigger students' critical thinking processes to increase. In accordance with the results of several previous researchers that the project-based learning model can improve students' critical thinking ability [17], [18]. The relationship between the steps of the project-based blended learning model and indicators of critical thinking ability, one of which is the project planning stage of students, seeking information and formulating problems or guiding questions. With this process students' critical thinking abilities are developed at this stage, namely the ability of formulating problems and determining problems. In this

activity, students learn to formulate problems in everyday life in the form of questions to get answers.

Likewise in the stage of project launch, students' critical thinking ability will be evolved with the process of finding sources or information related to the project theme designed. Students discussing in groups each member of the group is more motivated to understand the material, giving opinions to the group, and motivated to ask questions to the teacher and other groups and motivated to answer questions posed by other groups. This would be realized if students can plan well by drawing up a schedule.

The role of the teacher at the next step is helping students use resources to conduct inquiries and create products. The teacher monitors the progress of the project and helps overcome obstacles in completing the project. With E-Learning, students are always updated on project developments by uploading them to the Moodle application. Students' critical thinking abilities will be improved through making project. At the stage of testing the results and reconstructing, students test and evaluate the progress of their projects and the teacher measures the achievement and evaluates the progress of each student with E-Learning. The teacher asks the truth of the project through the application. Students are required to have the ability to answer and solve questions completely and correctly in carrying out calculations using the right strategy. Then, project completion requires students to use a variety of critical thinking skills, including logical reasoning, inductive and deductive reasoning, the capacity to evaluate, and the ability to offer logical arguments in decision-making [24].

4 Conclusion

Based on the findings of the research and discussion, it can be said that students' mathematical critical thinking skills are better when they use the Project Based Blended Learning model using the Moodle program than when they use traditional learning. The Project Based Blended Learning model with the Moodle Application can help students improve their critical thinking skills and also students' enthusiasm and interest in learning. By solving a problem outlined in a project carried out in groups using offline and online methods, students become more active, enthusiastic and easier to understand mathematical concepts.

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