

Application of Blended Learning to Increase Mathematics Learning Outcomes from Beginning Mathematics Ability

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Abstract:

The purpose of this study was to determine the effect of the blended learning model, with formative and summative assessments in terms of early mathematics abilities on the mathematics learning outcomes of high school students in the city of Palembang. Blended Learning Model, Types of assessment include formative and summative, early math skills include high and low. The method used is quasi-experimental, while the design used is treatment by level 2x2x2. The results showed that there was a significant improvement in the blended learning model with formative and summative assessments in terms of high and low early mathematics abilities on students' mathematics learning outcomes. Next; (1) a Blended learning model with formative assessment, can improve students' mathematics learning outcomes at high and low early math abilities, and (2) a blended learning model with summative assessment, can improve students' mathematics learning outcomes at high early math abilities.

Keywords: Blended Learning; SummativeFor, mative, Early Mathematics Ability, Mathematics Learning Outcomes

1. Introduction

Mathematics is a subject that is taught at every level of education in Indonesia, because every human being needs mathematics to meet practical needs and solve problems in everyday life, for example, can count, can calculate content and weight, can collect, process, present and interpret. data and can use calculators and computers (Lestari 2017). But in fact, both primary and secondary level mathematics educators generally realize that mathematics is not a subject that is easily understood by most students. According to the results of the Program for International Student Assessment 2012, Indonesia was ranked 64th out of 65 participants. An international test that measures students' abilities across countries in reading, math and science (OECD-PISA 2014). The low mathematics learning achievement of students in Indonesia shows that there is something that is not right in the mathematics learning process and the cause needs to be found to be improved, for example in the teaching and learning process and the implementation of the assessment of learning outcomes. (Zulkarnain 2019). Because learning methods that are suitable for students' initial abilities will play an important role in the teaching and learning process to improve student learning outcomes. (Hutagalung, Sari, and Wasilah 2018)

There is now an e-learning model and it is considered an excellent substitute for providing educational services, as it does not have the barriers of traditional/conventional education in classrooms and laboratories (Elyas 2018). E-learning is the development of computer technology and software, communication and information, to be employed in the teaching and learning process, where it has become one of the alternatives in the dissemination of education and activates training, both directly and indirectly, overcoming the barriers of space and time and risk, using modern communication mechanisms; to support the educational process, enrich and improve quality (Hussein 2011).

2. Literature Review

E-learning that supports face-to-face learning is in the form of blended learning, where the material content is better and enriched with an effective system. Research in (Yilmaz and Orhan 2010) blended learning model has been widely used worldwide especially in universities because it depends on the complementary blending of internet learning and web-based learning with face-to-face learning and free learning environments. In research (Lee et al. 2007), implementing the blended learning model, the teacher can teach the first few sessions in the classroom. Once the student has got an overview of the course, the teacher can then proceed to online teaching and interaction. Ideally, if we can combine the advantages of classroom teaching and e-learning, the learning effect will be enhanced and expanded with the blended learning model. (Arkorful and Abaidoo 2015)

Another problem that often occurs in learning mathematics is the technique and implementation of assessments of student learning outcomes, among which teachers tend to be less varied in providing assessments of the exercises or math problems given. (Surapranata 2009) said that there is no general rule that states the number of intensity lecturers must provide formative assessments to students. But in this case, the important benchmark is the achievement of the objectives (competency standards, basic competencies, and indicators) contained in the curriculum. Research has shown that technological aids such as calculators and computers have an increasing effect on students' attitudes towards mathematics (A'yun, Sujiwo, and Hidayatullah 2019). Summative evaluation is an evaluation that is carried out after one subject has been given (Menéndez et al. 2019). In other words, evaluation is carried out after all lesson units have been taught (Magdalena, Oktavia, and Nurjamilah 2021). The main purpose of this summative evaluation is to determine the value that symbolizes the success of students after they have taken a teaching program within a certain period (Udijono 2007). A teacher is also involved in summative and formative evaluation when revising lessons or learning materials using information obtained from their previous predecessors (Broadbent, Panadero, and Bouda 2018). Sometimes we talk about student formative assessment. This means that we assess the quality of student achievement according to the planned learning objectives, while students are still in the learning process. The results of these assessments can help us in planning the next step of student learning (Nitko 1996).

On the other hand, the ability is part of the overall skill. The initial state can also be seen as a composition of several facts that exist at the beginning of a particular teaching and learning process and are influential, as long as teachers and students interact to achieve certain specific instructional goals. Students who have good initial abilities will be illustrated that these students understand the subject matter faster than students who do not have initial abilities in the learning process (Razak 2018). Students with good prior knowledge as a

prerequisite for knowledge will not cause difficulties in developing further material to obtain maximum learning outcomes (Oyedeki 2017). This is by the opinion that the ability of students at the beginning of the lesson is the ability needed to achieve instructional goals (Lestari 2017).

Furthermore, of the problems and hypotheses that exist in this study, the purpose of the study is only to find out; 1). the effect of applying blended learning with formative assessment on early mathematics abilities on students' mathematics learning outcomes, 2) the effect of applying blended learning with summative assessment on early mathematics abilities on students' mathematics learning outcomes.

3. Methods

For the problems and objectives to be achieved, this study uses a Quasi-Experimental Model with the 2X2X2 ANAVA experimental method by level design (Kadir 2015). Research variables include independent variables, moderator variables and dependent variables. The independent variables which are the treatment variables are 1). Learning Model (A) consists of; (A1) Blended learning model and (A2) conventional model, 2). Type of Assessment (B) consists of; (B1) Formative assessment and (B2) Summative assessment, 3). The Moderator Variables of Early Mathematics Ability (C) consist of; (C1) High early mathematical ability and (C2) low early mathematical ability, and 4). While the dependent variable is the student's mathematics learning outcomes.

The research design was chosen to provide an overview of the answers to the research questions from three different treatments for students' mathematics learning outcomes, namely the treatment of learning models and types of assessments as well as early mathematics abilities on students' mathematics learning outcomes. The sample groups were formed based on three treatment factors in the experimental method. Three-way (2x2x2) analysis of variance by design level (Kadir 2015). There will be eight different treatment groups that are densely packed as seen in Table 1:

Table 1. Research Design

A ₁				A ₂			
B ₁		B ₂		B ₁		B ₂	
C ₁	C ₂	C ₁	C ₂	C ₁	C ₂	C ₁	C ₂
A ₁ B ₁ C ₁	A ₁ B ₁ C ₂	A ₁ B ₂ C ₁	A ₁ B ₂ C ₂	A ₂ B ₁ C ₁	A ₂ B ₁ C ₂	A ₂ B ₂ C ₁	A ₂ B ₂ C ₂

Of the eight groups in question, six groups were treated with blended learning, namely: 1). Groups of students with high early mathematics ability were given blended learning treatment and formative assessment, and 2). Groups of students with high early mathematics ability were given blended learning treatment and summative assessment, 3). The group of students with high early mathematics ability was given conventional treatment and formative assessment, 4). The group of students with high early mathematics ability and given

conventional treatment with summative assessment, 5). Groups of students with low early math abilities were given blended learning and formative assessment, 6). The group of students with low early mathematics abilities were given blended learning and summative assessments.

The affordable population in this study were all students of State Senior High School Plus 17 Palembang and State Senior High School 5 Palembang in class XI IPA. Based on the data obtained, the number of population members is 264 students spread over 4 classes at SMAN 5 Palembang (XI IPA 1, IPA 2, IPA 3 and IPA4) and 4 classes at SMAN Plus 17 Palembang (XI IPA 3, IPA4, IPA 5 and IPA 6). Of the eight classes that were randomly selected, they were given an initial mathematical ability test, the results were sorted from the smallest to the largest of all students in the 8 selected classes, then the group of students with high early mathematics ability was 27% of the upper group and 27% of early mathematics ability. lower group (Surapranata 2009). Based on the existing population, calculations were carried out on the sample group, which was 27% of the 264, as many as 71 students in the high group and 71 students in the low group. Furthermore, randomly selected to determine the students who became the sample, as many as 12 samples for each group/class of the existing 8 classes so that the total is 96 samples. This research was carried out in the odd semester from August to September 2020 as many as 10 meetings, where in one week there were two meetings for the 2019/2020 school year. The instruments used consisted of (1) early mathematics ability test instruments, and (2) students' mathematics learning outcomes test instruments. Both instruments use multiple choice with five options. Before using the instrument, it was first assessed by 3 experts, tested by 20 panellists and tested on 200 respondents, then tested the validity with biserial points and reliability with the KR-20 formula calculated using Microsoft Excel Windows 2013.

Data analysis techniques used in this study include Inferential analysis using 2x2x2 analysis of variance with F_{test} and t_{test} , the aim is to test the main effect, interaction effect, and simple effect. This analysis was carried out based on data on students' mathematics learning outcomes after being given blended learning, summative and formative assessments on high and low early mathematics abilities.

4. Results and Discussion

4.1. Results

The results of the data normality test using the Liliefors test in all groups of cells resulted in a value of $A_{count} < L_{table}$ at $\alpha = 0.05$, thus it can be concluded that the distribution of the selected data in all groups came from a normally distributed population. The homogeneity test using Fisher's exact test at $\alpha = 0.05$ gives the value of $F_{count} < F_{table}$, while the homogeneity test with the Barlett's test at the significance level $\alpha = 0.05$ produces $\chi^2_{count} < \chi^2_{table}$, thus the sample data comes from a population with homogeneous variance. With the requirements of the analysis met, the analysis of variance is feasible to use. Hypothesis testing was carried out by using a 3-way ANOVA analysis of variance followed by a t-test. The results of data analysis with ANOVA are presented in Table 2.

Table 2. Calculation Results of Three Way Variance Analysis

Number	Source	JK	df	RJK	F _{count}	F _{table}
1.	Among A	51,042	1	51,042	14,873	3,949
2.	Among B	63,375	1	63,375	18,467	3,949
3.	Among C	60,167	1	60,167	17,532	3,949
4.	Interaction A * B	112,667	1	112,667	32,830	3,949
5.	Interaction A * C	155,042	1	155,042	45,178	3,949
6.	Interaction B * C	165,375	1	165,375	48,189	3,949
7.	Interaction A * B * C	140,167	1	140,167	40,843	3,949
8.	In	302,000	88	3,432		
9.	Total	1049,833	95	11,051		

From table 2 obtained: 1). $F_{\text{count}} = 14,873 > F_{\text{table}} = 3.949$ at $\alpha = 0.05$, then H_0 is rejected. This means that it can be said that there are differences in the mathematics learning outcomes of students who are given a blended learning model and students who are given a conventional learning model. 2). $F_{\text{count}} = 18.467 > F_{\text{table}} = 3.949$ at $\alpha = 0.05$, then H_0 is rejected. This means that it can be said that there are differences in the mathematics learning outcomes of students who are given formative assessments with students who are given summative assessments. 4). F_{count} the interaction effect AB = $32.830 > F_{\text{table}} = 3.949$ at $\alpha = 0.05$, then H_0 is rejected. Thus it can be said that there is an interaction effect between the learning model and the type of assessment on mathematics learning outcomes. 5). F_{count} the effect of AC interaction = $45.178 > F_{\text{table}} = 3.949$ at $\alpha = 0.05$ then H_0 is rejected. Thus, it can be said that there is an interaction effect between the learning model and early mathematics abilities on mathematics learning outcomes. 6). F_{count} interaction effect BC = $48.189 > F_{\text{table}} = 3.949$ at $\alpha = 0.05$ then H_0 is rejected. Thus, it can be said that there is no interaction effect between the type of assessment and early mathematics ability on mathematics learning outcomes. 7). F_{count} ABC interaction effect = $40,843 > F_{\text{table}} = 3,949$ at $\alpha = 0,05$ then H_0 is rejected. Thus it can be said that there is an interaction effect between the learning model, the type of assessment and the initial ability of mathematics to the learning outcomes of mathematics.

Furthermore, because there is an interaction effect between learning models, types of assessments and initial mathematical abilities on students' mathematics learning outcomes, it can be continued to determine the simple effect, namely; a). The difference between the learning model on the type of assessment and the initial ability of mathematics to students' mathematics learning outcomes, b). The difference between the types of assessments in the

learning model and the initial ability of mathematics on students' mathematics learning outcomes using the t-test, the results are presented in Table 3.

Table 3. Summary of Simple Effect Tests A, B and C

Nunber	Hypothesis	t_{count}	$t_{\text{table}(0.05;88)}$	Discription	Results
1.	$\mu_{A1B1C1} > \mu_{A2B1C1}$	3,750	1,987	$t_{\text{count}} > t_{\text{table}}$	Significant
2.	$\mu_{A1B1C2} > \mu_{A2B1C2}$	4,250	1,987	$t_{\text{count}} > t_{\text{table}}$	Significant
3.	$\mu_{A1B2C1} > \mu_{A2B2C1}$	3,500	1,987	$t_{\text{count}} > t_{\text{table}}$	Significant
4.	$\mu_{A1B2C2} < \mu_{A2B2C2}$	-5,583	1,987	$t_{\text{count}} < - t_{\text{table}}$	Significant
5.	$\mu_{A1B1C1} > \mu_{A1B2C1}$	4,000	1,987	$t_{\text{count}} > t_{\text{table}}$	Significant
6.	$\mu_{A1B1C2} > \mu_{A1B2C2}$	4,500	1,987	$t_{\text{count}} > t_{\text{table}}$	Significant

From Table 3. obtained: Hypothesis of the difference between A in BC; 1). $t_{\text{count}} = 3.750 > t_{\text{table}(0.05;88)} = 1.987$ at $= 0.05$, then H_0 is rejected. This means that it can be said that in the group of students with high early mathematical abilities who were given formative assessments, there were differences in the mathematics learning outcomes of students who were given the blended learning model and students who were given the conventional learning model. 2). $t_{\text{count}} = 4,250 > t_{\text{table}(0.05;88)} = 1,987$ at $= 0,05$, then H_0 is rejected. This means that it can be said that in the group of students with low early mathematical abilities who were given formative assessments, there were differences in the mathematics learning outcomes of students who were given the blended learning model and students who were given the conventional learning model. 3). $t_{\text{count}} = 3,500 > t_{\text{table}(0.05;88)} = 1,987$ at $= 0,05$, then H_0 is rejected. This means that it can be said that in the group of students with high early mathematical abilities who were given a summative assessment, there were differences in the mathematics learning outcomes of students who were given the blended learning model and students who were given the conventional learning model. 4). $t_{\text{count}} = 5.583 > t_{\text{table}(0.05;88)} = 1.987$ at $= 0.05$, then H_0 is rejected. This means that it can be said that in the group of students with low early mathematical abilities who were given a summative assessment, there were differences in the mathematics learning outcomes of students who were given the blended learning model and students who were given the conventional learning model.

From Table 3. Obtained: Hypothesis of difference between B on AC; 5). $t_{\text{count}} = 4,000 > t_{\text{table}(0.05;88)} = 1,987$ at $= 0,05$, then H_0 is rejected. This means that it can be said that in the group of students with high early mathematical abilities who were given the blended learning model, there were differences in the mathematics learning outcomes of students who were given formative assessments with students who were given summative assessments. 6). $t_{\text{count}} = 4,500 > t_{\text{table}(0.05;88)} = 1,987$ at $= 0,05$, then H_0 is rejected. This means that it can be said that in the group of students with low early mathematical abilities who were given the blended learning model, there were differences in the mathematics learning outcomes of students who were given formative assessments with students who were given summative assessments.

4.2. Discussion

Blended learning is a virtual meeting between lecturers and students. They may be in different worlds but can give each other feedback, ask questions, answer, and interact between students and lecturers, or between students and students (Kaye 2013). There are various advantages of blended learning compared to ordinary conventional learning. Through

blended learning, students can be more successful in achieving learning objectives than conventional/face-to-face learning, as well as an increase in interaction and contact between students and between students and teachers either directly through chatting or email while online. On the other hand, the implementation of the assessment can be effective if it is carried out continuously and as often as possible. Because by carrying out the assessment as often as possible, the teacher can as soon as possible find out the advantages and disadvantages of the learning process that is being implemented. Giving formative tests regularly can improve student learning outcomes in calculus courses. Can foster a healthy competition climate among students because they do not want to get bad grades (Sunandar 2008). All data show and prove that students are assessed with formative assessments like to go to school and produce better progress than summative assessments (Tang 2013).

There is a relationship and connection between the blended learning model and the implementation of formative assessment because it pays attention to the learning process that takes place face-to-face or online. There is a relationship and linkage between the blended learning model and high early math skills because it pays attention to the learning process that takes place every face-to-face or online especially in online learning is limited by the time of independence while studying. The initial ability has a relationship to learning achievement, students who have high initial ability usually tend to have high learning achievement. Initial abilities are expected to be a positive impetus for students to study at a higher level. That is, with good initial abilities, students can follow and master the lessons well without any significant obstacles, especially at the beginning of the subject matter at the next level (Hasbullah 2014).

Students who have high initial abilities will more easily remember the information they have obtained, and more quickly understand the material that has been studied by seeing, observing, and observing directly from the material they read from books, literature on the internet, as well as from teacher explanations. so quickly understand the material being studied. When following lessons and working on questions, students who have high initial abilities will easily follow and answer questions well. Students who have high initial abilities have high curiosity, perseverance and independence. So it will be more suitable if given learning with blended learning with formative assessment.

5. Conclusion

The results of the study have implications for the learning process and the types of assessments in the classroom, especially on the blended learning model with formative or summative assessments at the high and low levels of early mathematical ability used in the classroom. (1) The blended learning model with formative assessment can improve students' mathematics learning outcomes at high early mathematics abilities and low early mathematics abilities. (2) The blended learning model with summative assessment can improve students' mathematics learning outcomes in early high mathematics abilities.

The conclusions and implications of the research are expected; (1) The blended learning model can be used as a learning model for students who have high early mathematics abilities with formative assessment because in this study it is proven to be able to improve students' mathematics learning outcomes, (2) High school teachers who teach mathematics should before carrying out the learning process hold prior knowledge of mathematics test to determine students' previous knowledge, so that students understand the importance of prior

knowledge with the material to be studied and teachers can group students in class according to their abilities, (3) To improve students' mathematics learning outcomes in mathematics subjects, teachers are expected to be more skilled in applying the blended learning model in high initial abilities with summative assessments in each mathematics learning activity.

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