STUDENTS' MATHEMATICAL PROBLEM ABILITIES IMPROVEMENT USING BLENDED LEARNING REVIEWED FROM THE INITIAL ABILITY OF STUDENTS

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ABSTRACT

The purpose of this study is to see an increase in students' mathematical problem-solving abilities taught by using a blended learning model in terms of the initial ability of high school students. Blended learning is digital-based learning by using digital learning media as aids in learning. This learning is done as a form of implementation of Education 4.0-based learning which the impact of the existence of Industrial Revolution 4.0. This research uses a quasi-experimental type with a pre-test post-test control design research design. The sampling technique was carried out using purposive sampling and obtained as many as 28 students who were in the experimental group (who were taught using a blended learning model) and 25 students who were in the control group (who were taught using ordinary learning). The results of testing normality and homogeneity of data using Levenes' test and Kolmogorov-Smirnov analysis obtained the results that the data in both learning groups were normally distributed and homogeneous. Referring to the prerequisite test results, hypothesis testing is performed using a Two-Way Analysis of Variance (ANOVA Two Path). The results of hypothesis testing indicate that there is an increase in students' mathematical problem-solving abilities that are taught using blended learning models in terms of students' initial mathematical abilities. This result strengthens the evidence that the use of blended learning models has a significant effect on improving students' mathematical abilities and provides new learning experiences for students.

1. INTRODUCTION

Today the world of education is developing quite rapidly along with the development of technology, information, and communication (ICT). The development that occurred had a significant impact on learning. One of them is the term Education 4.0 which is the impact of the emergence of the Industrial Revolution 4.0 era (Mourtzis, Vlachou, Dimitrakopoulos, & Zogopoulos, 2018). This can be seen with the demands of digital-based learning. Learning is required to be done anywhere and anytime. Learning is done by giving new experiences to students so that later students can explore more about the abilities they have. The development of learning finally urges educators to also make changes in the delivery of teaching that has been done so far only centered on the teacher (teacher-centered) (Ramadhani, Astuti, & Setiawati, 2019).

So far, direct learning (didactic learning) is one of the learnings that is often used in learning mathematics in the classroom. However, there is a big problem, namely, the teacher holds full control in the learning process. Direct learning or commonly known as ordinary learning is learning that only focuses on providing material without developing the abilities possessed by students. Students are not active in the learning process, students also only wait for instructions from the teacher whether to take notes or do assignments. This makes learning boring, monotonous and students become passive and not confident (Ngaeni & Saefudin, 2017; Harahap, 2018). This problem is still often found in schools, especially high schools where teachers who teach at this level should focus more on developing the ability of individual students so that students know the abilities that stand out in them. The presence of the Industrial Revolution 4.0 provides a good opportunity for teachers to make changes in the delivery of teaching in the classroom. Through the development of Education 4.0, teachers are free to explore the abilities that exist in students and can provide scaffolding to students when students experience obstacles in the learning process. So that later educators are able to produce students who are capable of pedagogic dimensions, life skills, the ability to live together (collaboration), and think critically and creatively as demands in the world of the Industrial Revolution era 4.0 (Lase, 2019).
Through Education 4.0, the learning approach will be focused on student-centered learning. Student-centered learning (SCL) is constructivist learning where the teacher not only transfers knowledge to students but also contracts knowledge into the student (Krishnan, 2015). SCL recommends students be actively involved as instructors in education that are empowered to decide what, when, where, and how to learn (Judi & Sahari, 2013). This method has also been proven to be able to increase student learning success when compared to the application of teacher-centered based learning methods (Gelisli, 2009), even students are positive about the application of this method (Alsalhi, Eltahir, & Al-Qatawneh, 2019).

One learning model that is digital based and can be applied in contemporary learning is the blended learning model. The blended learning model is a learning model that is an organic integration between face-to-face learning and computer-based learning, both online and offline, which is carried out through e-learning (Graham, 2006; Jones, 2006; Widiara, 2018). This learning model is very fast developing globally because it looks able to preserve traditional learning methods that have evolved over the centuries although at the same time there is a temptation to hand over the Education function to new technology (Nazarenko, 2015).

In this learning model, the teacher can provide face-to-face learning at the beginning of the session, after students gain an understanding of the initial material to be studied, then online-based learning (Lin, Tseng, & Chiang, 2017). Blended learning is able to change the learning paradigm from passive learning to active learning and provide opportunities for students to learn independently or in groups (Kaur, 2013). Borba, et al. (2016) conduct research related to the application of blended learning, e-learning and mobile learning in mathematics learning, and obtain results that online-based learning has a real effect in improving students' mathematical learning abilities. The use of technology helps students understand teaching material and helps teachers provide teaching materials in a more complex and enjoyable way. More than 45% of the world's human population can now access the internet (Borba, et al., 2016). This makes us aware that the use of technology in learning is not new and can be applied easily. However, the use of technology in learning must still consider several things, one of which is not to replace the role of the teacher in the learning process in the classroom (Fazal & Bryant, 2019). The role of a teacher or instructor in blended learning is crucial (Singer & Stoicescu, 2011). Although blended learning is seen as useful, enjoyable, very helpful, flexible, and able to motivate students, these factors are not enough to create a successful learning atmosphere (Güzer & Caner, 2014).

Learning using blended learning that is applied in the classroom is expected to provide an increase in students' mathematical abilities. Students' Mathematical ability is currently experiencing a decrease, especially the ability to solve mathematical problems. This can be seen from the results of research conducted both by PISA in 2018 and by TIMSS in 2015 where students at level 2 and above experienced difficulties, especially in terms of solving contextual and complex problems. (Mullis, Martin, Foy, & Hooper, 2016; OECD, 2019). Meanwhile, the ability to solve problems is one of the basic abilities that must be possessed by students, especially high school students (Ramadhan, 2018). The ability to solve problems has five indicators derived from Polya, namely understanding the problem, planning problem solving, carrying out problem-solving, and checking the results of problem-solving. In the problem-solving ability, the type of problem used is a non-routine and contextual problem. Non-routine problems are problems that are obtained in the real world but do not have specific formulas that can be solved using different strategies and categorize them into creative thinking abilities (Özreçberoğlu & Çağanağa, 2018).

Discussion
Blended Learning Model
The blended learning model is learning that combines traditional learning and learning activities using digital learning applications (e-learning) that use asynchronous and synchronous elements of distance learning (Krajnc, 2012). Blended learning is also said to be the 'third generation' of the distance learning system (Akyüz & Samsa, 2009). Blended learning is increasingly popular because it has proven to be an effective approach to accommodate an increasingly diverse student population while adding value to the learning environment through the incorporation of online teaching resources (Alammary, Sheard, & Carbone, 2014). In this learning, students first learn directly as usual learning and then proceed with learning using e-learning. E-learning based learning can be used in the classroom and outside the classroom (Lopes & Soares, 2018). Some types of blended learning models are Flipped Classroom. A flipped classroom is a pedagogical model where the educator and homework elements of the learning are reversed (Bergmann & Sams, 2012). This model allows students to gain knowledge before they enter the class to take part in face-to-face learning with the help of technology where students gain unlimited access to electronic resources (Evseeva & Solozhenko, 2015). Following is the syntax of the blended learning model presented in the image below:
Table 1 Syntax Blended Learning Model (Ramadhani, Umam, Abdurrahman, & Syazali, 2019)

<table>
<thead>
<tr>
<th>Step</th>
<th>Procedure</th>
<th>Student Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Orientation to the Problem</td>
<td>Students understand the details of the issue to be discussed. The problem is taken from teaching materials that have been presented through the material on e-learning.</td>
</tr>
<tr>
<td>2</td>
<td>Student Organization</td>
<td>Students are grouped into several discussion groups to solve the problems presented. Students can also discuss through e-learning.</td>
</tr>
<tr>
<td>3</td>
<td>Group Investigation</td>
<td>Students discuss in groups regularly to understand and criticize the problems presented and what solutions can be taken in solving problems.</td>
</tr>
<tr>
<td>4</td>
<td>Presenting Troubleshooting</td>
<td>Student groups will present solutions to problems that have been obtained both directly and through videos uploaded to e-learning.</td>
</tr>
<tr>
<td>5</td>
<td>Analysis and Evaluation</td>
<td>Students and teachers jointly analyze the results of the presentation of problem-solving and criticize the results until later to evaluate and draw conclusions.</td>
</tr>
</tbody>
</table>

Mathematical Problem Solving Ability

Problem-solving ability is the ability to solve mathematical problems that are non-routine, contextual, and complex. The purpose of learning mathematics by developing mathematical problem-solving abilities for students is to develop students’ basic abilities in solving problems encountered in daily life and be able to apply mathematical concepts in real situations. Individual ability is a good predictor of mathematical problem-solving activities in general (Samo, 2017). The success or failure of improving students’ problem-solving skills depends on understanding the concept. So in this case, the indicators of mathematical problem-solving abilities used in this study are referred to as the indicators that have been prepared by Polya. Among those are to understand the problem, planning problem solving, carrying out problem-solving, and checking the results of problem-solving (Gurat & Guzman Gurat, 2018; Polya, 2014; Ramadhani, 2019).

2. METHODOLOGY

This study uses a quasi-experimental type with a pre-test post-test control group design. Quasi-experiment is an experiment where the smallest unit of an experiment is placed in an experimental and control group which is not done randomly (non-random assignment) (Hastjarjo, 2019). Before the treatment of the research, a sample is conducted, the first step is to select the research sample from a population pool using a purposive sampling technique. The results of the sampling process obtained that there were 28 students who were grouped in the experimental group and 25 students who were grouped in the control group. Students in the experimental group will be given treatment or treatment that is taught by using a blended learning model, while students in the control group are not given any treatment (or in other words learning that is done is the same as learning normally done by teachers in the classroom).

The research data collection technique is done by providing essay tests of 5 questions with the type of contextual and open-ended questions with the categories of questions, 1 item is a category of synthesis questions (difficulty level of difficult questions), 2 questions are categories of application questions (moderate difficulty level) and The other 2 questions are categories of understanding questions (difficulty level of easy questions). Furthermore, the research data that has been collected will be tested for pre-requirements related to the normality and homogeneity of research data using the Levenes' test and Kolmogorov-Smirnov with the help of the SPSS 25.0 application.

Based on the pre-requisite testing results, the research data will be analyzed to test the research hypotheses that have been formulated at the beginning of the study. Hypothesis testing uses the Two-Way Analysis of Variance (ANOVA Two Path) test with the initial ability of mathematics as a factor variable. This test was also carried out with the help of the SPSS 25.0 application.

3. RESULT AND DISCUSSION
The results of the analysis of research data indicate that the average value of students' mathematical problem-solving abilities taught by using blended learning models is higher than the average value of students' mathematical abilities taught by using ordinary learning. This can be seen in Table 2 below:

<table>
<thead>
<tr>
<th>Table 2 Description of Students Mathematics Problem Solving Ability Value Based on Learning Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
</tr>
<tr>
<td>Pre-Test_Class_Experiment</td>
</tr>
<tr>
<td>PostTest_Class_Experiment</td>
</tr>
<tr>
<td>PreTest_Class_Control</td>
</tr>
<tr>
<td>PostTest_Class_Control</td>
</tr>
<tr>
<td>NGain_Class_Experiment</td>
</tr>
<tr>
<td>NGain_Class_Control</td>
</tr>
</tbody>
</table>

Based on Table 2 above, it was found that the pre-test and post-test scores of students in the experimental group both the minimum and maximum values were higher than those in the control group. The same thing also happened to the average value of students' mathematical problem-solving ability in the experimental group was higher both in the pre-test (59.1071) and in the post-test (81.0714) compared to the pre-test (51.6400) or in post-test (73.8400) in students who were in the control group.

To see how much an increase in students' problem-solving abilities, we can use normalized gain (NGain) pioneered by Hake (Hake, 1999). Based on table 2 it can also be seen that the average NGain value of students in the experimental class (0.5282) is higher than the average value of NGain students in the control class (0.4492).

The next stage is to conduct prerequisite testing on the two research data namely data normality test and data homogeneity test. The test results can be seen in Table 3 and Table 4 as follows:

<table>
<thead>
<tr>
<th>Table 3 Research Data Normality Test Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistic</td>
</tr>
<tr>
<td>Kolmogorov-Smirnova</td>
</tr>
<tr>
<td>Shapiro-Wilk</td>
</tr>
</tbody>
</table>

* This is a lower bound of the true significance.

a. Lilliefors Significance Correction

<table>
<thead>
<tr>
<th>Table 4 Homogeneity Test Results of Research Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Levene Statistic</td>
</tr>
<tr>
<td>NGain_Total</td>
</tr>
<tr>
<td>Based on Median</td>
</tr>
<tr>
<td>Based on Median and adjusted df</td>
</tr>
<tr>
<td>Based on trimmed mean</td>
</tr>
</tbody>
</table>

Based on tables 3 and 4 it is found that the two research data both obtained a value of .200 and this value is greater than the significance value (.200 > 0.05). It can be concluded that the two research data are normally
distributed. The same thing was obtained in the homogeneity test that is equal to 0.526 and this value is greater than the significance value (0.526 > 0.05). It can also be concluded that the research data is homogeneous.

Referring to the prerequisite test results and the results obtained that both research data are normally distributed and homogeneous, then hypothesis testing can be continued using the Two-Way Analysis of Variance (Two-Way ANOVA) test. The test results can be seen in Table 5 below:

**Table 5 Hypothesis Testing Results Using Two-Way Analysis of Variance Test**

(ANOVA Two Lines)

| Source                  | Type III Sum of Squares | df | Mean Square | F       | Sig.
|-------------------------|-------------------------|----|-------------|---------|-------
| Corrected Model         | .141*                   | 5  | .028        | 1.897   | .113  |
| Intercept               | 11.549                  | 1  | 11.549      | 777.507 | .000  |
| Class_Learning          | .062                   | 1  | .062        | 4.184   | .046  |
| KAM_Student             | .054                   | 2  | .027        | 1.828   | .172  |
| Class_Learning * KAM_Student | .008                  | 2  | .004        | .255    | .776  |
| Error                   | .698                   | 47 | .015        |         |       |
| Total                   | 13.613                 | 53 |             |         |       |
| Corrected Total         | .839                   | 52 |             |         |       |

a. R Squared = .168 (Adjusted R Squared = .079)

Based on Table 5 above, the results show that the significant value in the learning class factor is smaller than the p-value of significance (0.046 < 0.05). This shows that there is a significant difference between the results of students' mathematical problem-solving abilities in two classes of learning and also there is a higher and significant increase in the results of students' mathematical problem-solving abilities taught by using blended learning models compared to students taught with normal learning.

Furthermore, to see whether there is an interaction between students' initial abilities with an increase in the results of students' mathematical problem-solving abilities in both learning, then it can be seen in Figure 1 below:

**Figure 1 Interaction Test between Learning Classes with Initial Students' Mathematics Ability (KAM)**

Based on Figure 1 above, it can be seen that the two linear lines do not intersect. This shows that there is no interaction or role and contribution of the Beginning Mathematics Ability (KAM) of students to increase the results of students' mathematical problem-solving abilities in both learning classes. This result can also be seen from the previous Table 5 namely on the Classroom Learning Factors*KAM Students get a value of 0.776 and this value is greater than the p-value of significance (0.776 > 0.05). So it is proven that there is no interaction between KAM students on improving students' mathematical problem-solving abilities in both learning classes.

These results are in accordance with the results that have been obtained by Ramadhani (Ramadhani, Umam, Abdurrahman, & Syazali, 2019; Ramadhani, 2018) that mathematical abilities of students can be increased without the role of KAM students but is caused by the provision of new learning, one of which is the blended learning model.
This model has also been previously proven to be able to support students' mathematical thinking and help in overcoming additional obstacles in learning mathematics, such as in multivariable calculus learning, where blended learning is said to be an ideal environment to support students' thinking power through creative problem solving (Kashefi, Ismail, Yusof, & Rahman, 2012; Kashefi, Ismail, & Yusof, 2012). Students have positive feedback on mathematics when blended learning is applied (Lin, Tseng, & Chiang, 2017).

Many studies have proven or at least suggest that the use of blended learning is beneficial to student learning. If arranged correctly and using a natural digital environment for students, it can benefit from both forms of education (traditional and online) in the teaching of mathematics (Lilla, 2014). Students who learn in a blended learning approach have a better conceptual understanding than their peers because they can access learning material and revisit some difficult material in their free time. (Setyaningrum, 2018). Blended learning is also able to increase students' knowledge to a higher level of thinking, by developing student reasoning and motivation, which is based on student-centered approaches (Dzakiria, Wahab, & Abdul Rahman, 2013; Russell, 2014; Powell, et al., 2015; Murtikusuma, et al., 2019). This model is able to take advantage of a variety of learning to be able to meet students' needs personally based on their learning style, level of knowledge, passion, abilities, and skills (Baro, 2011). Students are more responsible for their own learning because they can access the learning content at any time and they apply the knowledge they have gained in class (Vernadasakis, Giannousi, Derri, Michalopoulos, & Kioumourtzoglou, 2012). In other words, the use of technology in learning can help students to become independent learners (Derlina, Dalle, Hadi, Mutalib, & Sumantri, 2018).

Not only students but the use of blended learning is also beneficial for educators and education staff. Significantly, with a small fee for managing time, academics can produce assignments that give students instant formative feedback and thereby encourage active participation and student development (Rossiter, 2006). Blended learning is also beneficial for educators (Drysdale, Graham, Spring, & Halverson, 2013) because it gives them the opportunity to have face-to-face classes but also begins to expand their expertise in the online environment, even though their needs are sometimes ignored. From the explanation above it can be understood that the implementation of the latest technology in the learning process can make learning more effective (Dalle & Ariffin, 2018).

4. CONCLUSION & SUGGESTION

Based on the results of the study can be obtained that the provision of learning by using a student-centered approach and learning based on blended-learning, then has a real effect in increasing students' mathematical problem-solving abilities. In addition to students experiencing a significant increase in mathematical abilities, students also gain new experiences in gaining learning, students gain new knowledge in using technology and students are more active and creative in following the process of learning mathematics. Not only students but teachers also benefit from the application of blended learning models, namely teachers gain new experiences and improve the ability of teachers to use technology in learning.

Learning using blended learning can be used in learning and any material. The application of this model is also recommended for use in middle-level students to students in tertiary education.

5. REFERENCES


Bergmann, J., & Sams, A. (2012). Flip your classroom: reach every student in every class every day. Arlington: ISTE.


