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Improving Conceptual Understanding of Mathematics Through Blended Learning Using Google Classroom

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Abstract: The 2018 PISA results recommend increasing learning achievement by improving teaching quality and learning climate. Responding to these recommendations, it is necessary to improve the quality of teaching and student learning climate, one of which is applying blended learning. This pre-experimental study aims to determine the increased conceptual understanding of mathematics through blended learning using Google Classroom. This study used one group pretest-posttest design, and data were collected through a test of conceptual understanding of mathematics. This research involved 14 junior high school students. Descriptive statistic effect size and inferential t-tests are used in analyzing research data. The research results show a difference in the average score in conceptual understanding of mathematics before and after applying Blended learning using Google Classroom. In other words, it is empirically proven that conceptual understanding of mathematics can be improved through Blended learning using Google Classroom with a magnitude of effect increase of 76%. In comparison, 24% were influenced by other factors.

INTRODUCTION

One of the objectives of learning mathematics is to understand mathematical material in the form of facts, concepts, principles, operations, and mathematical relations and apply them flexibly, accurately, efficiently, and precisely in solving mathematical problems (mathematical understanding and procedural skills) (Kemdikbud Ristek, 2022). Conceptual understanding mathematics is essential because it is one of the skills to deal with the industrial revolution (Baiduri, 2019). It is based on the that mathematics conceptual understanding allows one to solve problems better (Zulkarnain & Budiman, 2019), has rules in conceptualizing (Suandito, 2017), and can develop ideas (Hutagalung, 2017).

Kilpatrick, Swafford, & Findell stated that conceptual understanding refers to (1) an integrated and functional grasp of mathematical ideas, (2) knowing more than isolated facts and methods, (3) understanding why a mathematical idea is crucial and the kinds of contexts in which is it practical, (4) organized their knowledge into a coherent whole, which enables them to learn new ideas by connecting those ideas to what they already know, (5) supports retention because facts and methods learned with understanding are connected, they are easier to remember and use, and they can be reconstructed when forgotten, (6) attempt to explain the method to themselves and correct it if necessary, and (7) being able to represent mathematical situations in different ways and knowing how different representations can be helpful for different purposes (Kilpatrick, Swafford, & Findell, 2001). In this study, operationally, the conceptual understanding of mathematics is demonstrated by the ability to (1) present the concept in various representations, (2) link various concepts, (3) apply the concept algorithmically, and (4) develop necessary or sufficient requirements of a concept.

PISA defines mathematical literacy as an individual's capacity to formulate, use, and interpret mathematics in various contexts. Mathematical literacy includes mathematical logic, concepts, procedures, facts, and devices to describe, describe, and predict a phenomenon (Kemdikbud Ristek, 2019). Indonesian students tend to be weak in mathematics, except for PISA 2018. In mathematics, the average score on the PISA test for Indonesian students fluctuates; the lowest average score was obtained in PISA 2003, which was 360, and the highest average score was achieved in PISA 2006, 391 points. At PISA 2018, Indonesian students obtained an average score of 379 (level 1, lower bound score of 358 out of 6 levels, lower bound score of 669). In Indonesia, about 71% of students still need to reach the minimum competency level in mathematics. It means that many Indonesian students still have difficulty dealing with situations requiring problem-solving abilities using mathematics (Kemdikbud Ristek, 2019).

Based on the results of the 2018 PISA, it is recommended to increase learning achievement by improving the quality of teaching and learning climate (Kemdikbud Ristek, 2019). Responding to these recommendations, efforts are needed to improve the quality of teaching and student learning climate. One effort that can be made is to apply blended learning Because many studies indicate that blended learning positively impacts learning outcomes. For example, blended learning methods are more effective in academic achievement and attitudes towards mathematics than traditional methods (Lin, Tseng, & Chiang, 2017), have a better conceptual understanding than those who apply conventional teaching methods (Setyaningrum, 2018), and affects students' conceptual understanding of mathematics (Huda, et al., 2019; Ulfa & Puspaningtyas, 2020; Indrapangastuti, Surjono, Sugiman, & Yanto, 2021).

Blended learning combines face-to-face and online learning that aligns with current developments. Students are more interested and motivated to study more seriously and look for learning resources that are closer to them through devices or computers (Ulfa & Puspaningtyas, 2020), feel happier and attractive not easily bored during the lesson (Fitri & Zahari, 2019), and can help them to learn mathematics at their own pace and express their opinions (Lin, Tseng, & Chiang, 2017).

The five key ingredients of the blended learning process (Carman, 2005) are (1) live events, (2) online content, (3) collaboration, (4) assessment, and (5) reference materials. Blended learning is an innovative concept that embraces the advantages of traditional classroom teachings and ICT-supported learning, including offline and online learning. It has scope for collaborative, constructive, and computer-assisted learning (CAI) (Lalima & Dangwal, 2017).

There are four blended learning models (Staker & Horn, 2012) (1) rotation model (station rotation, lab rotation, flipped classroom, dan individual rotation), (2) flex model, (3) self-blend model, dan (4) enriched-virtual model. Based on some of the classification models above, this study uses the rotation and flipped classroom models. It is because the flipped classroom model includes several elements of student control over time, place, track, and learning speed (Staker & Horn, 2012). It used an allocation of time between face-to-face and online classes where online classes are not allocated to replace face-to-face meetings.

One of the services that can support blended learning is google classroom because google classroom has four features, namely stream, classwork, people, and grades (Google Classroom, n.d.) which can facilitate the five key ingredients of the blended learning process. Google Classroom is an effective platform for educators to use for various educational purposes and can increase student engagement with ad hoc sessions using follow-up Q&A, tasks and discussion topics (Beaumont, 2018). Teachers can take advantage of the many features available in Google Classroom, such as assignments, ratings, communications, time costs, archival courses, mobile applications, and privacy (Ni, 2020). Google Classroom is versatile (blended learning, flipped classroom and exclusively online classrooms), easy to use from both a staff and student perspective and allows for collaborative work to be undertaken easily (Beaumont, 2018).

Blended learning can be used as an alternative to improve students' conceptual understanding of mathematics (Setyaningrum, 2018; Indrapangastuti, Surjono, Sugiman, & Yanto, 2021). When each student has a computer with access to teaching resources, they can control their learning progress and learn without interruption. Students can browse learning materials as much as they need and repeat exercises to understand the content (Lin, Tseng, & Chiang, 2017). Online assessment and immediate feedback can help to improve learning effectiveness (Lin, Tseng, & Chiang, 2017). Implementing integrated learning through Google Classroom can enhance students' ability to build social networks to pursue knowledge (Ni, 2020). Moreover, it improves student and teacher interaction and facilitates group discussion and collaborative learning (Lin, Tseng, & Chiang, 2017).

In addition, Tang and Chaw highlighted that the blended learning model benefits students, especially its flexibility in terms of time, place, and accessibility (Tang & Chaw, 2013). (Tuomainen, 2016) revealed that the blended learning model can enhance (1) students' enthusiasm for learning due to the comfort and flexibility in time management; (2) student's learning preferences; and (3) students' autonomy to be more independent and responsible with regard to their own learning. Moreover, (Mozelius & Hettiarachchi, 2017) point outed that a combination of face-to-face and online learning activities, or blended learning, is better than a single method. Likewise, (Albhnsawy & Aliweh, 2016) mentioned that blended learning activities offer many opportunities for teachers and students to receive feedback and exchange perspectives. Based on the description above, this research will prove whether the conceptual understanding of mathematics can be improved through blended learning using Google Classroom.

METHOD

This research is a pre-experimental study with the One Group Pretest Posttest Design. The effect of treatment is determined by calculating the difference between the pretest and posttest of the dependent variable (Cranmer, 2017). The population in this study were 14 students in grade VIII junior high school in Jambi City, so all students were used as the research sample (total sampling). Blended Learning uses Google Classroom as the independent variable and students' understanding of mathematical concepts as the dependent variable.

The instrument of this research is a test of conceptual understanding of mathematics. It consists of four items that measure: (1) the ability to present concepts in various representations; (2) connecting various concepts; (3) algorithmically applying concepts; and (4) developing necessary or sufficient requirements from a concept on basic competence (1) distinguish and determine the surface area and volume of rectangular shapes (cubes, blocks, prisms, and pyramids) and (2) solve problems related to surface areas and volumes of rectangular shapes (cubes, blocks, prisms, and pyramids). Descriptive and inferential statistics were used in data analysis. Descriptive statistics are used to describe scores of students' conceptual understanding of mathematics in the form of the highest scores, lowest scores, range, average, median, mode, standard deviation, and magnitude of influence. Inferential statistics are used to analyze whether the conceptual understanding of mathematics can be improved through blended learning using Google Classroom. The t-test was used for this analysis, which was previously tested for the normality of the data. Students' conceptual understanding of mathematics increases if the t-test is statistically significant, and the magnitude of the increase in understanding is categorized into low (d=0.2), medium (d=0.5), and high (d=0.8) categories (Fritz, Morris, & Richler, 2011).

RESULT AND DISCUSSION

Blended Learning Using Google Classroom

Mathematics learning is carried out in 4 meetings in 2 weeks. The material taught is rectangular shapes, including the surface area and volume of cubes, cuboids, pyramids, and prisms. The Blended Learning process using Google Classroom is operationally carried out in two stages: online learning and face-to-face learning (Lalima & Dangwal, 2017) with the Rotation Model sub Flipped Classroom Model (Staker & Horn, 2012).

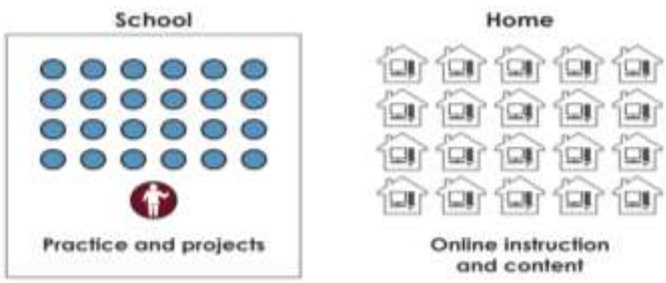

Figure 1. *Flipped Classroom Model* (Staker & Horn, 2012)

The first stage is online learning which is carried out independently. At this stage, students are given material and look for the content from various references from books and online sources related to the material to be discussed. This activity can increase student learning enthusiasm due to convenience and flexibility in time management, learning preferences, and student independence and responsibility for their learning (Tuomainen, 2016). Using many learning resources makes it easy for students to find the meaning of the material being discussed by concluding some of the learning references they have obtained (Ulfa & Puspaningtyas, 2020), and students can understand the concept of the material being discussed (Setyaningrum, 2018; Indrapangastuti, Surjono, Sugiman, & Yanto, 2021).

In addition, if during online learning, there are some parts of the material that are poorly understood, Students can browse learning materials as much as they need and repeat exercises to understand the content (Lin, Tseng, & Chiang, 2017). Students can also ask them during the face-to-face learning process later. Another thing done during online learning is giving and submitting assignments directly uploaded via Google Classroom. It can be assessed online and provide direct feedback (Albhnsawy & Aliweh, 2016) to help improve learning effectiveness (Lin, Tseng, & Chiang, 2017).

The second stage is direct (face-to-face) learning. This activity can increase interaction between students and teachers and facilitate group discussions and collaborative learning (Lin, Tseng, & Chiang, 2017). Class meetings are used to discuss and clarify problems faced by students during the online learning process and to discuss students' difficulties when doing assignments given online. This activity can increase student involvement through follow-up questions, answers, assignments, and discussion topics (Beaumont, 2018).

Students have sufficient time to work on practice questions in face-to-face learning (Lin, Tseng, & Chiang, 2017). Conceptual understanding is formed during online learning and supported by face-to-face learning will help students avoid high levels of error in solving problems (Kilpatrick, Swafford, & Findell, 2001) thereby enabling better problem-solving (Zulkarnain & Budiman, 2019). If the conceptual understanding is good and correct, students will have no difficulty solving problems using mathematics, as expected in the PISA test (Kemdikbud Ristek, 2019).

Descriptive statistics

Following are the results of descriptive statistics for conceptual understanding of mathematical scores before and after applying blended learning using Google Classroom:

Tabel 1. Comparison of Descriptive Statistics of Pretest and Posttest Scores

No.	Criteria	*Pretest*	*Posttest*
1	Highest score	69	94
2	Lowest score	19	25
3	Range	50	69
4	Mean	39.3	50.4
5	Median	34.5	47
6	Mode	56, and 19	62
7	Standard deviation	17.0	18.3

From the table above, there are two data measures, the first is the central tendency, which consists of the mean, median and mode, and the second is the measures of dispersion, which consists of the range and standard deviation. Based on the data, it can be seen that the highest score during the post-test (94) is higher than the pretest (69), as well as the lowest score during the post-test (25) is higher than the pretest (19). The mean score of the post-test (50.4) is higher than the pretest (39.3), and so is the post-test median (47) higher than the pretest (34.5) and the post-test mode (62) higher than the pretest (56 and 19).

The mean, median, and mode gains at the posttest were relatively high, indicating an increased conceptual understanding of mathematics through blended learning using Google Classroom. In contrast, the standard deviation value at the posttest (18.3) was greater than the pretest (17.0) due to the posttest range (69) greater than the pretest (50). Descriptively, students' conceptual understanding of mathematics can be improved through blended learning using Google Classroom.

Inferential Statistics

Before the t-test is carried out, the data's normality assumption is fulfilled. Obtained distribution of pretest data ($l_{statistic}$= 0.21< l_{tabel} = 0.227) and posttest ($l_{statistic}$= 0.17 < l_{tabel} = 0.227) normally distributed. Then proceed with the t-test and obtain t statistic ($\mathbf{t_o}$= 5.19) and t tabel ($\mathbf{t_{t.5\%}}$= 2.16; $\mathbf{t_{t.1\%}}$= 3.01) so that t_o is greater than $\mathbf{t_t}$ (2.16 < 5.19 > 3.01) at a significance level of 5% or 1%. To find out the magnitude of the effect that Blended Learning using Google Classroom has on increasing conceptual understanding of mathematics Effect Size from Cohen's d is used (Fritz, Morris, & Richler, 2011) and obtained Effect Size with moderate category (d=0.7) with a percentage of 76%.
There is a difference in the mean score for conceptual understanding of mathematics before and after applying Blended learning using Google Classroom. In other words, it is statistically proven that conceptual understanding of mathematics can be improved through blended learning using Google Classroom with an increase in the effect of 76%. In comparison, 24% is influenced by other factors.

Based on the descriptive and inferential findings above, it is evident that conceptual understanding of mathematics can be improved through blended learning using Google Classroom. This finding is in line with previous findings that blended learning is more effective in academic achievement and attitudes toward mathematics than traditional methods (Lin, Tseng, & Chiang, 2017), has a better conceptual understanding than those applying conventional teaching methods (Setyaningrum, 2018), has a positive effect and more effective to improves students' conceptual understanding of mathematics (Huda, et al., 2019; Ulfa & Puspaningtyas, 2020; Indrapangastuti, Surjono, Sugiman, & Yanto, 2021). Students feel happier, more interested, and not quickly bored, which can increase activity, conceptual understanding, and student learning outcomes (Fitri & Zahari, 2019).
Google Classroom, which has four features: streams, classwork, people, and grades (Google Classroom, n.d.), rotated with face-to-face learning, will be better than a single method (Mozelius & Hettiarachchi, 2017). his activity can increase interaction between students and teachers and facilitate group discussions and collaborative learning (Lin,

Tseng, & Chiang, 2017). Teachers can take advantage of the many features available in Google Classroom, such as assignments, ratings, communications, time costs, archival courses, mobile applications, and privacy (Ni, 2020).

Through the Rotation Model sub-model Flipped Classroom Model, students will be more interested and motivated to study more seriously and look for learning resources closer to them through devices or computers (Ulfa & Puspaningtyas, 2020) Students are not easily bored during learning (Fitri & Zahari, 2019), and it can help them learn mathematics at their own pace and express their opinions (Lin, Tseng, & Chiang, 2017). When each student has a computer with access to teaching resources, they can control their learning progress and learn without interruption. Students can browse learning materials as much as they need and repeat exercises to understand the content. Online assessment and immediate feedback can help to improve learning effectiveness (Lin, Tseng, & Chiang, 2017). Google classroom functions to overcome certain limitations for both teachers and students, especially in terms of time, space, conditions, and circumstances (Indrapangastuti, Surjono, Sugiman, & Yanto, 2021) and blended learning can be used as an alternative to increasing students' conceptual understanding of mathematics (Setyaningrum, 2018; Indrapangastuti, Surjono, Sugiman, & Yanto, 2021).

CONCLUSION

The descriptive and inferential findings prove that Blended learning using Google Classroom can improve conceptual understanding of mathematics. It is recommended that teachers improve the conceptual understanding of mathematics through Blended learning using Google Classroom because it has been proven that it can be improved. This study used a pre-experimental one-group pretest-posttest design with a low internal research validity level. It is suggested that future researchers use a more stringent design to control other variables outside the research variables, such as a pretest-posttest control group design or other designs.

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