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Peningkatkan Pemahaman Konsep Matematika Siswa Melalui Model Pembelajaran Flipped Classroom untuk Siswa Kelas VIII SMP

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Abstrak

Tujuan dari penelitian ini adalah untuk mengetahui perbedaan peningkatan pemahaman konsep matematis antara siswa kelas VIII SMP Negeri 2 Bintan yang menggunakan model pembelajaran *Flipped Classroom* dan pembelajaran konvensional. Penelitian ini merupakan penelitian kuantitatif yang menggunakan jenis penelitian *Quasi Experiment* dengan desain *non-equivalent control group design.* Teknik pengambilan sampel menggunakan *cluster sampling.* Sampel pada penelitian ini berjumlah 25 siswa dari kelas VIII A dan VIII D. Instrumen penelitian ini berupa lembar wawancara, lembar observasi, dan soal uraian sebanyak 5 soal. Soal yang dibuat kemudian di uji validitas, uji reliabititas, uji tingkat kesukaran, dan uji daya pembeda. Uji prasyarat yang dilakukan adalah uji normalitas dan homogenitas kemudian diperoleh hasil data yang berdistribusi normal dan kedua kelompok homogen. Hasil penelitian menunjukkan bahwa siswa di kelas eksperimen memperoleh peningkatan pemahaman konsep matematis rata-rata sebesar 0,35 sedangkan siswa kelas kontrol memperoleh peningkatan sebesar 0,21. Uji hipotesis menggunakan uji *independent t-test* dengan nilai *sig. (2 tailed)* sebesar 0,000. Karena uji ini adalah uji pihak kanan, maka *p-value* = $\frac{1}{2} \times 0{,}000 = 0$ dan diketahui $0 \leq 0{,}05$, sehingga H_a diterima. Dapat disimpulkan dari penelitian ini bahwa peningkatan pemahaman konsep matematis siswa yang belajar dengan model *Flipped Classroom* lebih tinggi dari siswa yang belajar dengan pembelajaran konvensional.

Kata Kunci: *flipped classroom*, pemahaman konsep matematis

Improving Students' Understanding of Mathematical Concepts Through the Flipped Classroom Learning Model for Class VIII SMP

Abstract

This study aimed to find out the difference between class VIII students of SMP Negeri 2 Bintan who used the Flipped Classroom learning model and conventional learning. This quantitative study uses a Quasy Experiment research type with a non-equivalent control group design. The sampling technique uses cluster sampling. The research instruments included interview sheets, observation sheets, and a description of 5 questions. The questions were then tested for validity, reliability test, difficulty level test, and discrimination test. The prerequisite tests carried out were the normality and homogeneity tests, and then the data results were normally distributed, and the two groups were homogeneous. The results showed that students in the experimental class obtained an average increase in their understanding of mathematical concepts by 0.35, while students in the control class obtained an increase of 0.21. Test the hypothesis using an independent t-test with a sig. (2-tailed) value of 0.000. Because this test is a right-hand side test, the p-value = $\frac{1}{2}\times$ *0.000 = 0, and it is known that 0 ≤ 0.05, so* H_a *is accepted. It can be concluded from this study that the increased understanding of mathematical concepts of students who learn with the Flipped Classroom model is higher than students who learn with conventional learning. It can be concluded from this study that the increased understanding of mathematical concepts of students who learn with the Flipped Classroom model is higher than students who learn with conventional learning.*

Keywords*: flipped classroom; understanding of mathematical concepts*

INTRODUCTION

Based on the results of the Programme for International Student Assessment (PISA) survey conducted every three years by the Organization for Economic Cooperation and Development (OECD) to measure the mathematical abilities of students such as the ability to analyze, solve, and interpret math problems in various forms and situations obtained results of Indonesian students mathematics rating in 2018 ranked 73rd out of 79 participating countries with a score of 379 from the International 500 average. This is confirmed by a study conducted by Mayasari & Habeahan (2021) that Indonesian students have a low ability to answer math questions, as much as 54%. This indicates that the ability of Indonesian students to answer math questions is in the low category. From these data, it was found that the cause of Indonesia's low achievement was due to students' need for more understanding of mathematical concepts (Khairani & Roza, 2016). Supported by research by Aisyah & Firmansyah (2021) regarding the results of the mathematical concept understanding test, showing 55.88% of students had a shared understanding of mathematical concepts. Furthermore, research by Fauziah, Rismen, & Lovia (2022), which was carried out through tests and interviews, obtained that around 39% of students' understanding of mathematical concepts was also low.

Several factors can influence the common causes of students' understanding of low mathematical concepts. According to Siregar (2017), students tend to think that mathematics is complicated, plus the symbols presented are abstract, and the mathematical operations used are complicated. In his research Radiusman (2020) said that currently, teachers teach mathematics only by presenting monotonous material using the lecture method so that students are not much involved in constructing their knowledge. In addition, the learning process that is carried out, from providing material, deepening the material, and explaining in class with a short lesson schedule, makes students prioritize memorizing concepts to make time efficient (Luritawaty, 2018). If this continues to be done, students' conceptual understanding of a subject matter will always be low. Therefore, teachers must design appropriate strategies to maximize students' understanding of mathematical concepts. One thing that can be done is to look at the characteristics of learning that are developing in the 21st century, namely student-centred learning, creating various valuable activities so that the learning process is not monotonous and boring and utilizing technology as a learning support medium. One learning model that meets these criteria is Flipped Classroom.

The Flipped Classroom learning paradigm flips or modifies student learning activities so that work often completed at home is now completed at school (Mutmainah, Setiawan, & Purwanto, 2019). In learning mathematics, of course this learning model is designed so that students are more sensitive or careful in understanding the material to be studied so that the involvement of understanding mathematical concepts is needed in these activities. One of the steps of the Flipped Classroom learning model is to provide subject matter before the lesson day begins so that there is still time to study and understand the material, so when in class, students are no longer reading material. However, students must actively convey their knowledge of what has been learned and understood before. This aligns with the opinion of Apriyanah, Nyeneng, & Suana (2018) that the Flipped Classroom learning model has opportunities for students to be active in voicing their knowledge because the teacher is no longer the leading actor in learning but rather a companion in the teaching and learning process.

The latest research in the field of improving students' understanding of mathematical concepts, particularly in Class VIII SMP, shows a variety of approaches that have been explored (Asti, Gunur, Jelatu, & Ramda, 2022; Herwandi & Kaharuddin, 2020; Rohmatulloh, Syamsuri, Nindiasari, & Fatah, 2022; Sukma, Ramadoni, & Suryani, 2022; Tamara, Maizora, & Hanifah, 2020; Wahyudi & Amir MZ, 2022). One such approach is the ELPSA learning model, which has undergone rigorous evaluation to determine its effectiveness in instilling a deep understanding of mathematical concepts among eighth-grade students at SMP Negeri 6 Makassar (Herwandi & Kaharuddin, 2020). Additionally, a separate study has explored the impact of implementing the Peer Teaching Flipped Classroom learning model on students' grasp of mathematical concepts (Sukma et al., 2022). Furthermore, the development of video learning media, facilitated by Sparkol Videoscribe, has been undertaken to provide students with an easily accessible medium for understanding mathematical concepts (Wahyudi & Amir MZ, 2022). Moreover, the Group Investigation cooperative learning model has been used to enhance the understanding of mathematical concepts within the scope of

junior high school education (Tamara et al., 2020). However, despite the comprehensive exploration of these various approaches, there remains an urgent need to improve students' understanding of mathematical concepts. Persistent challenges still exist, as evidenced by the extremely low levels of understanding observed in some studies (Asti et al., 2022). This issue cannot be solely attributed to the learning process but may also be related to inherent student attributes, such as emotional and spatial intelligence (Asti et al., 2022). Consequently, the novelty in the research surrounding "Improving Students' Understanding of Mathematical Concepts Through the Flipped Classroom Learning Model for Class VIII SMP" lies in the integration of the flipped classroom model with key factors encompassing emotional and spatial intelligence (Rohmatulloh et al., 2022).

In this study, the material for geometry flat side was chosen because one of the subjects is difficult for students to understand. Kristantini, Sumardi, & Zamzaili (2022) confirmed this, who stated that students experienced difficulties with material for flat-sided shapes. The geometry of flat side material is very closely related to everyday life. This is in line with what Riajanto (2020) conveyed, that geometry flat side material is beneficial for interpreting objects in real life. However, the conditions in the field, if the teacher gives practice questions different from those that have been exemplified, students tend to need explanation and make mistakes in answering these questions. The mistakes made by students generally lie in the use of formulas, understanding or ability to digest mathematical language, and the ability to apply concepts, this is because students only memorize formulas (Syahbana, 2013). The results of interviews conducted by researchers with mathematics teachers at junior high schools in Bintan reinforce the previous statement that students need help understanding to determine when to use the volume and surface area formulas if the questions presented contain everyday problems. Students also need an explanation when presented with a problem where a shape's volume or surface area is known and asked for length, height, width, or other measurements. In addition, the researcher also conducted interviews with students who had studied flat-sided geometric material in the previous class. It was found that students had difficulty finding volume and surface area when presented with a combined build and presented questions in the form of stories that related to everyday life. In line with the results of Hasibuan (2018), on testing geometry flat-side material questions for students, 70% of students had difficulty solving problems involving volume and surface area on cubes, blocks, prisms, and pyramids.

Previous research relevant to what was carried out by researchers, namely Walidah, Wijayanti, & Affaf (2020), state that Flipped Classroom can influence student learning outcomes and effectively improves students' critical thinking skills. Furthermore, research conducted by Juniantari, Pujawan, & Widhiasih (2019) states that students' understanding of mathematical concepts applying the Flipped Classroom model is higher than in conventional learning, the media used is in the form of learning videos on the Flipped Classroom model. The similarity's relevance is applying the Flipped Classroom learning model in measuring students' abilities. However, in this study, researchers focused on increasing students' understanding of mathematical concepts, and the media used to support the Flipped Classroom learning model is an interactive PPT containing explanatory videos and student worksheets (LKS). This is beneficial for students to understand better the concept of the material provided.

METHOD

The type of research used in this study was a quasi-experimental design with a non-equivalent control group design, which involved two classes, namely the experimental and control classes, by giving different treatments to both. The research was conducted at SMP Negeri 2 Bintan. The research was conducted for one month, from January to February, with the subject matter of the even semester, namely geometry flat-side for the 2022/2023 academic year. The research was conducted five times in the experimental class and control class. Before the first meeting, both classes were given a pretest to see students' initial abilities before being given treatment in learning. Furthermore, the experimental class was given to apply the Flipped Classroom learning model with supporting media in interactive PowerPoint and Student Worksheets (LKS). In contrast, the control class used conventional learning.

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After getting treatment in learning, the last meeting was given a posttest to see the students' final abilities. The research pattern for this design can be seen in Figure 1 (Sugiyono, 2016).

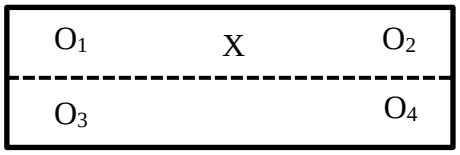

Figure 1. Research Pattern

This study's population were all class VIII students consisting of six classes, namely class VIII A to VIII F. The sampling technique in this study used cluster sampling by drawing lots of six classes so that two sample classes were obtained, namely class VIII D as the experimental class with a total of 25 people and class VIII A as the control class with a total of 25 people. The data collection technique was carried out using a test technique, namely giving questions in the form of descriptions. The instrument is given to students as an initial ability test (pretest) and at the end of learning (posttest). The pretest is given to see students' initial abilities before being given treatment in learning. After being treated in learning, students are given a posttest to see their final ability. The data obtained are each student's pretest and posttest scores, whose n-gain and average will be calculated. From the average n-gain, the increase obtained from the experimental class that applies the Flipped Classroom learning model and the control class that applies conventional learning can be seen.

To ensure that the test instrument used is suitable as a research instrument, it is necessary to test the validity, reliability test, difficulty level test, and distinguishing power test. Before the four tests were carried out, the test instrument in the form of description questions, as many as five questions were tried out to class IX, who had studied this geometry flat side material in the previous class. After being tested and tested for feasibility, it was found that all instruments on students' understanding of mathematical concepts were declared valid and had a reliability value of in the pretest questions 0.614 and posttest questions 0.654. As well as having a moderate category at the difficulty level and a suitable category on the distinguishing power. Data analysis techniques are activities after the research data has been collected. This study begins with calculating the normalized gain value between the pretest and posttest of each student. Then test the requirements for parametric statistics, namely the normality and homogeneity tests. If the data that has been tested fulfils both of these conditions, then it can be continued with hypothesis testing with the t-test, namely the independent sample t-test.

RESULTS

The main research results used in this study were data from the pretest and posttest results of students' understanding of mathematical concepts in the experimental and control classes. The results of the pretest for understanding mathematical concepts in the control class for the lowest score were 2, and the highest was 10, while the lowest scores in the posttest were 6 and the highest was 15. Furthermore, in the results of the pretest for understanding mathematical concepts in experimental class, students for the lowest scores were 4, and the highest was 11, while in the posttest, the lowest score was 9 and the highest score was 17. To see differences in increasing students' understanding of mathematical concepts between the experimental class and the control class, the data processing was carried out in the following stages:

1. Calculating the normalized gain data

The normalized gain is calculated to support the research results to obtain data on increasing students' understanding of mathematical concepts from the two sample classes. The n-gain data was obtained from the pretest results of students' understanding of mathematical concepts before treatment and the post-test results of understanding students' mathematical concepts after treatment. It was found that the highest n-gain in the experimental class was 0.53, and in the control class, the highest n-gain was 0.38. When compared, the n-gain results of the experimental class with the Flipped Classroom learning model are higher than the control class, which learns using conventional learning models. Furthermore, it is known that the average n-gain of the experimental class is higher than the average n-

gain of the control class. This can be seen from the experimental class' average n-gain value of 0.35 in the medium category and the control class's average n-gain of 0.21 in the low category.

Based on these gains, to see whether the difference in this enhancement was significant or not, a statistical test was carried out. The data used must be normally distributed as a condition for conducting statistical tests. Therefore, first a normality test was carried out on n-gain to determine whether the data from the two sample classes used were normally distributed.

2. Normality Test

The normality test was carried out using the SPSS 23-assisted Shapiro-Wilk test. In the normality test, $\boldsymbol{H_0}$ is accepted if the p-value is more than $\alpha = 0.05$ and is rejected if the opposite is true. The results of the calculation of the N-Gain data normality test can be seen in Table 1.

Table 1. *Normality test results*

N-Gain Value		Shapiro-Wilk		
	Class	**Statistic**	**df**	**Sig.**
	Eksperimen	.939	25	.139
	Kontrol	.929	25	.084

Table 1 shows that the significance value of the n-gain data score for the experimental class is 0.139, and for the control class is 0.084. Based on the test criteria, the data resulting from increasing students' understanding of mathematical concepts in both classes come from normally distributed samples. This is because the significance value is more than 0.05, so H_0 is accepted.

3. Homogeneity Test

The homogeneity test was carried out using the Levene test with the help of SPSS 23. The test criterion to determine the homogeneity of N-Gain data is if the significance value is > 0.05. The n-gain data is taken from a population that has a homogeneous variance. Furthermore, conversely, if the significance value is < 0.05, the data is not homogeneous. The results of the N-Gain data homogeneity test calculations for the two classes can be seen in Table 2.

Table 2. *Homogeneity test results*

N-Gain Value	Homogeneity Test		Result
	Sig.	**Interpretation**	
	0,071	H_0 diterima	Homogen

Based on Table 2, it is found that the significance value of the N-Gain data is more than 0.05. The experimental and control class groups come from populations with a homogeneous variance.

4. Hypothesis Test

Hypothesis testing was carried out using the Independent T-test test for N-Gain data with the following statistical hypothesis formulation:

H_0: $\mu_1 = \mu_2$

H_a: $\mu_1 > \mu_2$

The test criteria used are if P-value = α, at a significance level of 0.05, then H_0 is rejected. In the opposite condition, if the P-value > α, then H_0 is accepted, or Ha is rejected. The test carried out is a one-party test (right-hand test), so the P-value (2-tailed) must be divided by 2 (Stanislaus, 2009). The results of the Independent T-test test calculation for N-Gain data values from the two classes can be seen in Table 3.

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Table 3. *The results of the different tests increased students' understanding of mathematical concepts*

	Levene's test for Equality of Variances		**T-*test* for Equality of Means**		
Equal variances assumsed	**F**	**Sig.**	**t**	**df**	**Sig. (2-tailed)**
	3.414	.071	5.404	48	.000

Based on Table 3, it is found that the value of Sig. (2-tailed) that is 0.000. Because the test is one-sided (*right side test*), the P-value = $\frac{1}{2} \times 0.000 = 0$. It is known that $0 \leq 0.05$, so H_0 is rejected, and Ha is accepted. That is, the average increase in understanding of mathematical concepts of experimental class students is higher than the average increase in understanding of mathematical concepts of control class students.

DISCUSSION

Researchers carried out learning activities in two sample classes, namely the control class and the experimental class, with reference to the learning implementation plan. The researcher applies the Flipped Classroom learning model to the experimental class with syntax consisting of providing subject matter at least 1 day before learning begins, forming discussion groups, working on worksheets, providing opportunities to convey the results of discussions, providing opportunities to ask or answer questions, giving reinforcement to discussion results, and drawing conclusions. Both classes were given pretest and posttest to see students' abilities. Based on the results of data analysis, it was found that the results of the pretest understanding of mathematical concepts in the control class for the lowest score were 2, and the highest score was 10. The lowest posttest score for students' understanding of mathematical concepts in the control class was 6, and the highest was 15. With an average N Gain of 0.21. While the results of the pretest understanding of mathematical concepts for experimental class students for the lowest score of 4 and the highest score of 11. In the posttest understanding of mathematical concepts for experimental class, students for the lowest score of 9 and the highest score of 17 with an average N-Gain of 0.35. This indicates that the increase in students' understanding of mathematical concepts in the experimental class is more significant than the increase in their understanding of mathematical concepts in the control class. Similar research by Fauzi, Irawati, & Aeni (2022) obtained an average n-gain value of 0.23 for the experimental class and 0.19 for the control class. The results above show that students' understanding of mathematical concepts increases higher after applying the Flipped Classroom learning model in mathematics than conventional learning. This occurs naturally because, according to Fikri (2019), a learning model that can involve students actively thinking for themselves in order to find general concepts based on the materials provided by the teacher, student learning opportunities at any time or that can be repeated, as well as discussion activities, is needed to develop students' understanding of mathematical concepts. Flipped Classroom, with its characteristics, is a learning model that can help students be more active in conveying their knowledge of what has been learned and understood before so that they can understand concepts better. This is because there are group discussion activities in one of the steps of implementing Flipped Classroom. Then, the results of these discussions are delivered individually, and students are allowed to ask questions or express opinions from other students. This is in line with what Apriyanah et al. (2018), that the Flipped Classroom learning model has opportunities for students to be active in voicing their knowledge because the teacher is no longer the leading actor in learning.

Recent research studies have spotlighted the efficiency of the Flipped Classroom model in diverse educational settings, showcasing its seamless integration with AI platforms for language acquisition (Li & Peng, 2022), its application in Multivariable Calculus courses (Harmini, Sudibyo, & Suprihatiningsih, 2022), its transformative influence on students' mathematical problem-solving abilities (Pratidiana, Pujiastuti, & Santosa, 2022), its impact on fostering student autonomy, its implementation through Edmodo to enhance comprehension of Geography concepts (Wardhani, Handoyo, & Budijanto, 2022), its undeniable effectiveness in ameliorating mathematics learning

outcomes (Ihda & Harahap, 2022), and its affirmative influence on student academic accomplishments (Ihda & Harahap, 2022; Khairani, Tanjung, & Rohani, 2022).

Although there is an increase in understanding of mathematical concepts in the experimental class compared to the control class, the N-gain obtained from the experimental class that applies the Flipped Classroom learning model can be seen as small in this study. According to the researcher, the small value obtained was due to the relatively short time of conducting the research, namely only 5 meetings. According to Milman (2014), applying the Flipped Classroom model to produce maximum results takes more or longer. This is related to the fact that the Flipped Classroom learning model can be implemented in learning, it's just that there needs to be a habit of student independence in learning because in Flipped Classroom has a syntax in the form of giving material to students at least one day before learning is carried out so that there is a need for independent learning habituation first. According to Novianska, Romdanih, & Hasanah (2021), the habit of independent learning for students takes approximately 8 weeks or about 2 months to get maximum or higher results. This shows that the longer or increasing the duration of the learning implementation, the better results will be.

The difference in increasing students' understanding of mathematical concepts between these two classes is due to differences in the treatment of the learning steps. The Flipped Classroom learning model places more emphasis on students understanding and finding concepts in the material that has been given and playing an active role in the learning process in class. At least one day prior to the start of class, students get material from the researcher in the form of an interactive PowerPoint presentation. Providing material before learning is carried out can make students learn the material first at home. This will facilitate learning in the classroom because previously, students already had the initial capital to learn and understand. In line with the opinion of Solahudin (2019) states that independent learning before the implementation of learning can provide students with a good understanding of concepts. Next of Juniantari et al. (2019), which state that providing material before learning begins can make students find their concepts in learning and have an initial view of the material before the lesson is implemented. Besides that, the Flipped Classroom learning model provides opportunities for students to carry out group discussions in class which are realized through working on student worksheets (LKS).

In working on the LKS, the researcher guides students in groups to discuss the questions that have been presented. Each student is asked to fill out the LKS. Most importantly, students not only fill out the LKS but also understand the subject matter at that time. After finishing working on the LKS, students as representatives of each group, convey the results of their group discussions, and other students provide responses or questions related to what has been submitted. It is intended that students play an active role in the learning process and steps to find out the understanding that students have. According to Murnaka & Dewi (2018), the existence of discussion activities and providing opportunities for students to play an active role in learning can improve students' understanding of mathematical concepts. During the student activity, the researcher appreciated every student who dared to express opinions, ask questions, or answer in the learning process. Furthermore, researchers provide responses, improve, and strengthen the results of answers and students' understanding of the material. Students are allowed to ask questions or exchange ideas or understandings. Then the researcher helps reflect on the learning that has been implemented.

On the other hand, learning mathematics with conventional learning models is carried out according to the learning stages prepared in the learning implementation plan. As the centre of learning, the researcher is tasked with conveying material directly while students listen more and pay attention to the teacher's explanations. Research by Jafar (2021) also conveys that conventional learning models emphasize the teacher's narrative and explanation orally, and the teacher is more dominant in learning. Here it can be seen that conventional learning is more dominated by the teacher as a knowledge transfer, while students are more passive as recipients of knowledge. In this lesson, it is sometimes difficult for the teacher to know whether students understand the material provided. Based on the explanation above, the increased understanding of mathematical concepts of students who learn with the Flipped Classroom learning model is higher than students who learn with conventional learning. Thus, applying the Flipped Classroom learning model to learning mathematics is better in increasing students' understanding of mathematical concepts than conventional learning.

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CONCLUSION

Based on the study's results, the average n-gain calculation results for the experimental class were 0.35, and the control class was 0.21. This shows that the increase in students' understanding of mathematical concepts in solid-sided geometrical material that applies the Flipped Classroom learning model is higher than in classes that apply conventional learning. This Flipped Classroom learning model can improve students' understanding of mathematical concepts. Therefore, applying the Flipped Classroom learning model can be a concern for teachers to apply it in the classroom learning in the hope that students' understanding of mathematical concepts will increase or even better.

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