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The Flipped Classroom Effect on Students' Self-Regulated Learning

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Abstract. The Covid-19 pandemic has had a significant impact on the education system around the world, leading to changes in the implementation of learning that reduce the number of face-to-face meetings and require students to engage in more self-regulated learning. To ensure optimal student learning achievement despite studying independently, teachers must select a suitable model. One alternative solution to increase self-regulated learning is the Flipped Classroom model. Therefore, this study aims to examine the effectiveness of the Flipped Classroom model in promoting students' self-regulated learning. To investigate the effectiveness of the Flipped Classroom model, a quasi-experimental research design was employed, using a pretest-posttest nonequivalent control group design at a State Islamic Junior High School in Kerinci, Jambi. Data was collected through a self-regulated learning questionnaire, and the hypothesis was tested using a t-test. The results of the study indicate that the Flipped Classroom model is highly effective in increasing students' self-regulated learning in mathematics. As such, this model is highly suitable for sustainable application at all levels of education in the future.

Keywords: Flipped Classroom; Mathematics Learning; Self-Regulated Learning

Abstrak. Pandemi Covid-19 berdampak signifikan pada sistem pendidikan di seluruh dunia, menyebabkan perubahan dalam pelaksanaan pembelajaran yang mengurangi jumlah pertemuan tatap muka dan menuntut siswa untuk terlibat dalam pembelajaran yang lebih mandiri. Untuk memastikan hasil belajar siswa yang optimal meskipun belajar secara mandiri, guru harus memilih model yang cocok. Salah satu alternatif solusi untuk meningkatkan kemandirian belajar adalah model Flipped Classroom. Oleh karena itu, penelitian ini bertujuan untuk menguji keefektifan model Flipped Classroom dalam mendorong pembelajaran mandiri siswa. Untuk menyelidiki keefektifan model Flipped Classroom, digunakan desain penelitian eksperimen semu, dengan menggunakan *pretest-posttest nonequivalent control group design* di salah satu Madrasah Tsanawiyah Negeri di Kerinci, Jambi. Data dikumpulkan melalui angket *self-regulated learning*, dan hipotesis diuji dengan menggunakan uji-t. Hasil penelitian menunjukkan bahwa model Flipped Classroom sangat efektif dalam meningkatkan kemandirian belajar matematika siswa. Dengan demikian, model ini sangat cocok untuk diterapkan secara berkelanjutan di semua jenjang pendidikan di masa depan.

Kata kunci: *Flipped Classroom*; Kemandirian Belajar; Pembelajaran Matematika

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INTRODUCTION

The Covid-19 pandemic has forced the Indonesian government to impose restrictions on community and educational activities (Setiana et al., 2021; Anhusadar, 2020; Baety & Munandar, 2021; Abidin et al., 2020). As a result, online learning has been implemented across all levels of education, from elementary to higher education, in order to continue the learning process (Firman & Rahayu, 2020). However, online learning requires students to be independent (Syelitiar & Putra, 2021), responsible for their own learning, and proficient in utilizing information technology to manage their space and time effectively, as well as to plan and select relevant resources (Yulia & Putra, 2020).

The quality of learning outcomes is strongly influenced by students' self-regulated learning (Beishuizen, 2011; Lynn et al., 2011; Zimmerman & Schunk, 2011). Students who possess high levels of self-regulated learning tend to be more effective in managing their learning patterns, completing assignments in a timely manner, and achieving higher grades (Yusuf, 2011; Velayutham & Aldridge, 2013). Erita's (2021) study demonstrates that students with self-regulated learning skills are better equipped to actively and efficiently manage their study time, organize and control their actions, and solve mathematical problems (Kramarski et al., 2010). Montroy et al. (2016) have also confirmed that self-regulated learning is a key predictor of future success, which highlights the importance of developing this trait in students from an early age.

However, the learning approach used in the classroom can hinder the development of student self-regulated learning, particularly in teacher-centered models, where students tend to memorize learning materials without the ability to solve problems independently when presented with different questions (Fauzan et al., 2018). This trend can impede the achievement of the goals of mathematics learning and lead to less meaningful knowledge acquisition. Therefore, it is crucial to facilitate students in developing their self-regulated learning skills in order to attain their learning objectives more effectively. Every teacher should strive to achieve this important goal.

To promote self-regulated learning, it is essential to change students' perception of their role in the learning process. However, the success in developing student self-regulated learning also depends on the chosen learning strategies, methods, and models (Mabruroh & Suhandi, 2017; Mailantri et al., 2020). One of the most effective learning methods to engage students both physically, mentally, and socially, while following the planned learning objectives, is the Flipped Classroom (Yulietri & Mulyoto, 2015). By using the Flipped Classroom method, students can learn at their own pace and use classroom time to deepen their understanding of the material (Erita, 2021). As students have studied the material at home, they come to class prepared to be guided, and the lecture process reinforces what they have learned independently.

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It is important to note, however, that the effectiveness of the Flipped Classroom model can vary depending on the design and research subjects, as Lee (2018) has pointed out. In this study, the authors used video assistance and provided learning materials, such as handouts, to facilitate self-regulated learning. Additionally, some exercises had to be completed at home to promote student self-regulated learning. Therefore, the purpose of this research is to examine the effect of the Flipped Classroom learning model on student self-regulated learning in mathematics. By doing so, the study aims to contribute to the growing body of research on the effectiveness of the Flipped Classroom model and its impact on students' self-regulated learning in mathematics.

METHOD

The research methodology employed in this study is a quasi-experimental research design with a nonequivalent control group. The study was conducted at a State Islamic Junior High School in Kerinci, Jambi, involving two groups of students. The experimental group received the Flipped Classroom Model treatment, while the control group utilized the conventional model. To identify student self-regulated learning, both groups were given a validated self-regulated learning questionnaire consisting of 30 statements that covered several indicators such as being daring to take action, understanding learning needs, confident in problem-solving, confident in one's own abilities, not relying on others, completing tasks on time, and being diligent.

During the trial, it was found that all 30 statements met the validity criteria, and the instrument's reliability was confirmed by obtaining a Cronbach Alpha coefficient of 0.971, which is considered reliable and meets the requirements. The questionnaire was administered twice, at the beginning and end of the study, to gauge student self-regulated learning. To analyze the data, paired sample t-tests were used if the data met the criteria of being normally distributed and homogeneous.

RESULTS AND DISCUSSION

The Data of Pretest and Posttest in Experimental Group

Based on the scores of respondents' answers, the research results show that students in the experimental group who used the Flipped Classroom model experienced increased self-regulated learning, as demonstrated in Figure 1.

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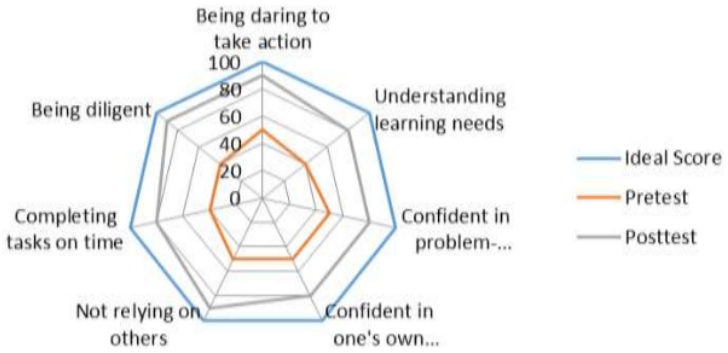

Figure 1. Spiderweb Graph for Pretest and Posttest in Experimental Group

As per the graph in Figure 1, it can be observed that the average pretest score for self-regulated learning was 50%, which is considered low, while the average posttest self-regulated learning score was 80%, indicating a high level of self-regulated learning. This improvement can be attributed to the fact that students were asked to summarize material notes from the video and handouts provided by the researcher prior to learning, which helped them to better understand the material.

To determine the effectiveness of the Flipped Classroom model in promoting self-regulated learning, researchers used the N-Gain score, which is the difference between the pretest and posttest values. Before testing the hypothesis, the researchers conducted normality and homogeneity tests. Table 1 presents the normality test results for the pretest and posttest of the experimental group. The results showed that the pretest and posttest values were normally distributed, as indicated by a Sig > 0.05.

Table 1. N-Gain Normality Test Results for Pretest and Posttest Experimental groups

Test in Experimental Group	Sig. Value	Interpretation
Pretest	0,178	Normal
Posttest	0,200	Normal

Furthermore, Table 2 displays the homogeneity test results for the control and experimental groups. The results revealed a Sig value > 0.05, suggesting that the control and experimental groups were homogeneous.

Table 2. Homogeneity Test Results

Parameters	Levene Statistic	df1	df2	Sig
Based on Mean	2.511	3	86	0.064
Based on Median	2.459	3	86	0.068
Based on the Median and with adjusted df	2.459	3	66.928	0.070
Based on trimmed mean	2.523	3	86	0.063

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The normality and homogeneity tests show that the data are normally distributed and homogeneous, so the t-test is used to test the hypothesis.

Table 3. Experimental group Hypothesis Test Results

Variable	t-count	Sig	Level of Significant
Pretest dan Posttes Experiment	-29,682	0,000	0,05
N = 22			

Table 3 presents the experimental group hypothesis test results, which showed a significant increase in self-regulated learning using the Flipped Classroom model, as measured by seven indicators: being daring to take action, understanding learning needs, confident in problem-solving, confident in one's own abilities, not relying on others, completing tasks on time, and being diligent.

The significant increase in self-regulated learning using the Flipped Classroom model is consistent with previous research by Mirlanda et al. (2019), which highlighted the benefits of Flipped Classroom in providing students with ample time to understand and study materials at home through handouts or learning videos. This approach enables students to be well-prepared before the learning process and to use classroom time effectively to deepen their understanding of the material (Reidsema et al., 2017).

The Data of Pretest and Posttest in Control Group

Based on the scores of the respondents' answers, the results of self-regulated learning were obtained, as shown in Figure 2.

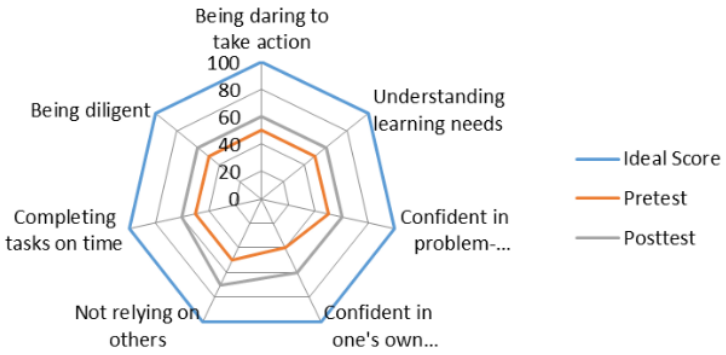

Figure 2. Spiderweb Graph for Pretest and Posttest in Control Group

According to Figure 2, it can be inferred that the students in the control group experienced an improvement in self-regulated learning using conventional models. It is apparent that the average pretest score for self-regulated learning was 50%, which falls under the low category, while the average posttest self-regulated learning score was 60%, which falls under the medium category. The increase in self-regulated learning in the control group can be attributed to several factors

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related to the steps of the conventional model, which were measured through self-regulated learning indicators.

To see the effectiveness of the learning model on self-regulated learning, we look for the N-Gain score. The difference between the pretest and posttest values, the N-Gain test is used to determine the effectiveness of using conventional models before and after treatment to control group research subjects. Before testing the hypothesis, prerequisite tests were carried out, namely the normality and homogeneity tests. The results of the pretest-posttest normality test for the control group are presented in Table 4.

To assess the effectiveness of the learning model on self-regulated learning, we used the N-Gain score, which measures the difference between pretest and posttest values. The N-Gain test was employed to determine the effectiveness of using conventional models before and after treatment on the control group research subjects. Before testing the hypothesis, we conducted prerequisite tests, including normality and homogeneity tests. Table 4 shows that the pretest and posttest scores have a Sig value > 0.05, indicating that the pretest and posttest values of the control group are normally distributed.

Table 4. N-Gain Normality Test Results Pretest and Posttest Control group

Test in Control Group	Sig. Value	Interpretation
Pretest	0,200	Normal
Posttest	0,200	Normal

Additionally, the homogeneity test of the control and experimental groups can be seen in Table 5. Based on the results of the homogeneity test in Table 5, which also shows a Sig value > 0.05, we can conclude that the control and experimental groups are homogeneous.

Table 5. Homogeneity Test Results

Parameters	Levene Statistic	df1	df2	Sig
Based on Mean	2.511	3	86	0.064
Based on Median	2.459	3	86	0.068
Based on the Median and with adjusted df	2.459	3	66.928	0.070
Based on trimmed mean	2.523	3	86	0.063

Based on the results of the homogeneity test in Table 5, which shows a Sig value > 0.05, it can be concluded that the control and experimental groupes are homogeneous. Since the data are normally distributed and homogeneous, we used the t-test to test the hypothesis. The results of the hypothesis testing can be seen in Table 6.

Table 6. Results of the Control group Hypothesis Test

Variable	t-count	Sig	Level of Significant
Pretest dan Posttes Control	-6,626	0,000	0,05
N=23			

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Based on the paired sample t-test, a significance of 0.000 was obtained, indicating that there was a significant increase in the independence of learning mathematics in the control group from pretest to posttest. However, the increase was in the moderate category. It is worth noting that self-regulated learning is an affective (attitude) assessment, and students may answer it subjectively. This is in line with what was stated by Delima and Cahyawati (2021) that students' independence in learning mathematics is influenced by various factors that were not observed in this study, such as parental encouragement, facilities, and the use of effective strategies for punishment and reward.

In conventional learning, where the teacher is at the center of the learning process, student participation is often limited, resulting in lower self-regulated learning. To address this issue, there is a need to shift towards student-centered learning, as advocated by Franestian et al. (2020). This would require directing the student learning process more towards making observations, using patterns, employing thinking strategies, and taking responsibility for their learning.

As Mailantri et al. (2020) highlighted, the conventional model of learning is often criticized for its lack of student participation, leading to students merely memorizing and accepting what the teacher teaches. Lubis et al. (2020) also confirmed that the learning process will only be effective if the knowledge learned is meaningful for the students. Therefore, it is crucial to ensure that the learning that takes place in the classroom involves active student engagement, utilizing learning resources, exchanging information, and receiving feedback on their progress (Jensen et al., 2018).

The Comparison of the Flipped Classroom Model with the Conventional Model

The use of a flipped classroom in the experimental group was highly effective in increasing students' independence in learning mathematics compared to a control group that did not use a flipped classroom. This conclusion was drawn from the results of hypothesis testing using post-test values obtained from the experimental and control groups

Table 7. Hypothesis Test Results for Experimental and Control Groups

Variable	t-count	Sig	Level of Significant
Posttes (Experiment) & Posttest (Control)	20,756	0,000	0,05

Table 7 displays the hypothesis test results for both groups. The t-count is 20.756 with a probability value of 0.000. Based on the paired sample t-test, this indicates a significant difference between the average post-treatment value of the experimental group and that of the control group. These results suggest a significant increase in the independence of learning mathematics in the experimental group, which was found to be better compared to the control group. These findings were supported by the results of the post-test questionnaires administered to both groups.

The Flipped Classroom model aims to promote independent learning among students. This independence refers to students becoming initiators of their own learning process, actively seeking

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information and preparing themselves for lectures. Self-regulated learning is a crucial aspect of independent learning, as it involves the ability to regulate one's behavior and use strategies to achieve academic goals (Zimmerman, 2002). With self-regulated learning, one can regulate one's behavior, emotions, and behavior toward success in the school, work, and living environment (Strunk et al., 2014; Reeck et al., 2016).Students who engage in self-regulated learning are more likely to improve their academic skills and achieve higher levels of success (Altinay-Gazi & Altinay-Aksal, 2017; Khan, 2012).

The present study's findings support the notion that learning experiences must be structured to support one another and produce long-term impacts on learning (Richey & Klein, 2014). Additionally, the study's results suggest that providing students with more time for independent study may help them graduate more quickly (Moallem, 2019). These findings align with Delima and Cahyawati's (2021) research, which found that online learning during the Covid-19 pandemic required teachers to provide stimuli that could increase self-regulated learning.

Overall, the results of this study highlight the importance of promoting self-regulated learning among students, particularly in the context of the Flipped Classroom model. By providing students with the tools and strategies necessary to regulate their learning behaviors, educators can help students become more independent and successful learners.

CONCLUSION

Flipped Classroom model is a highly effective approach to increase students' self-regulated learning in mathematics. The study found that students who use the Flipped Classroom model have higher scores in self-regulated learning compared to those who use conventional models. The Flipped Classroom model encourages students to become more independent learners and take the initiative in their own learning process. This study provides strong evidence to support the implementation of the Flipped Classroom model in mathematics education at all levels of education.

However, it is recommended to conduct further research with a broader study that includes other cognitive and affective abilities beyond self-regulated learning. This will provide more insights into the effectiveness of the Flipped Classroom model in different areas of mathematics education. Additionally, further research could explore how the Flipped Classroom model can be adapted to fit different mathematics material at different levels of education.

Overall, the findings of this study have significant implications for mathematics education. The Flipped Classroom model is a promising approach that can help improve students' self-regulated learning in mathematics. By using this model, teachers can empower their students to

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take responsibility for their own learning and become more independent learners. This can lead to better academic achievement and long-term success in their academic and professional careers.

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