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Flipped Classroom in Mathematics Learning: Efforts to Improve Learning Outcomes and Self-Efficacy of MTs Students

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Abstract

Although low mathematics achievement and weak student self-efficacy remain persistent concerns in junior secondary education, evidence on the use of student-centered digital learning models in MTs mathematics classrooms remains limited. This study aimed to analyze the effectiveness of the Flipped Classroom learning model in improving mathematics learning outcomes and self-efficacy among eighth-grade students at MTsN 10 Agam. A quasi-experimental method with a posttest-only group design was employed. The population comprised all eighth-grade students across four classes, with class VIII.4 assigned as the experimental group and class VIII.1 as the control group through cluster random sampling. Data were collected using a mathematics achievement test and a self-efficacy questionnaire and analyzed using a t-test with SPSS. The findings showed that students in the experimental class achieved higher mathematics learning outcomes than those in the control class, with mean scores of 78.88 and 57.80, respectively, and a significant t-test result (tcount = 4.876 > ttable = 1.68). Students' self-efficacy was also higher in the experimental class than in the control class, with mean scores of 99.04 and 92.70, respectively,

supported by the hypothesis test result (tcount = 1.70 > ttable = 1.68). SPSS analysis further indicated a significance value of 0.000, confirming the effect of the Flipped Classroom model. These findings demonstrate that the Flipped Classroom learning model is effective in improving both mathematics learning outcomes and self-efficacy among MTs students. The study contributes to mathematics education by highlighting the pedagogical value of integrating technology and digital media to support independent learning, strengthen conceptual understanding, and enhance students' confidence in their mathematical abilities.

Keywords: Flipped Classroom; Learning Outcomes; Self-Efficacy; Mathematics Learning; Student-Centered Learning

INTRODUCTION

Education is a process aimed at developing students' full potential, including cognitive, affective, and psychomotor skills (Nurdiana et al., 2026). In the context of mathematics learning, student success is not only measured by conceptual mastery and learning outcomes, but is also influenced by affective aspects, one of which is self-efficacy (Wulandari et al., 2024). Hidayanti, (2023) explains that self-efficacy is an individual's belief in their ability to complete tasks and achieve specific goals. Students with high self-efficacy tend to be more confident, persistent in the face of difficulties, and able to maintain effort when solving math problems. Conversely, students with low self-efficacy tend to feel anxious, give up easily, and avoid tasks they perceive as difficult (Aziz, 2025). Therefore, mathematics learning outcomes and self-efficacy are two interrelated aspects that need to be developed in a balanced manner in the learning process.

However, this ideal condition has not been fully achieved at MTsN 10 Agam. Based on the results of observations and interviews with mathematics subject teachers conducted on December 8 and 17, 2025, it was found that most of the eighth grade students had not yet achieved the Learning Objective Achievement Criteria (KKTP) set by the school, which was 76. The summative mathematics results data of eighth grade students are presented in Table 1.

Table 1. Data on Summative Mathematics Results for Eighth-Grade Students

Class	Number of Students	KKTP	Number of Completions		Completion Percentage	
			< 76	≥ 76	< 76	≥ 76
VIII.1	20	76	15	5	75%	25%
VIII.2	22		18	4	81,82%	18,18%
VIII.3	24		20	4	83,33%	16,67%
VIII.4	25		11	14	44%	56%

Source: Mathematics Subject Teacher for Class VIII MTsN 10 Agam

Based on Table 1, it can be seen that the percentage of students achieving mastery is still low. Only 25% of class VIII.1 achieved mastery, 18.18% of class VIII.2, 16.67% of class VIII.3, and 56% of class VIII.4. These data indicate that most students still experience difficulties in achieving mathematics learning objectives. Interviews with teachers also revealed that students often experience anxiety, lack of confidence, and hesitation in solving mathematics problems. This issue is even more important to address because the research focused on Straight Line Equations, which requires conceptual understanding, the ability to represent relationships between variables, interpret graphs, and solve contextual problems (Oktarisa et al., 2024). Mastery of this material requires not only strong cognitive abilities but also student self-confidence to overcome challenges in the learning process.

The low learning outcomes and student self-efficacy are thought to be related to the teacher-oriented learning process (Septriansyah et al., 2023). Conventional learning results in the majority of class time being devoted to delivering material, while students' opportunities for discussion, expressing opinions, exploring concepts, and solving problems remain limited (Aisyah et al., 2017). These conditions result in students tending to be passive and lacking the opportunity to construct their own understanding (Falochi et al., 2023). Based on constructivist theory, learning will be more meaningful when students are actively involved in constructing their knowledge through discovery, discussion, and reflection on learning experiences. Therefore, a learning model is needed that can provide students with broader opportunities for independent learning while simultaneously increasing interaction and learning activities in the classroom (Nari et al., 2022).

One learning model that aligns with these characteristics is the Flipped Classroom. The Flipped Classroom model is a learning approach that reverses traditional learning patterns by providing students with the opportunity to study material through various digital media before face-to-face learning begins (Saputra & Anita, 2025). This allows classroom

learning activities to focus on more meaningful activities such as discussion, collaboration, problem-solving, and providing intensive feedback (Robiah et al., 2024). Through this independent learning process before learning begins, students have the opportunity to develop an initial understanding of concepts, while classroom activities can strengthen mathematical thinking skills and increase confidence in problem-solving.

Various previous studies have shown that the Flipped Classroom model has a positive impact on mathematics learning outcomes. Fauzi et al., (2022) found that students who participated in learning using the Flipped Classroom model achieved better learning outcomes than students who learned using the conventional model. Similar findings were also reported by Sarumaha et al., (2023), who stated that the implementation of the Flipped Classroom model was able to improve student learning outcomes in the implementation of the Independent Curriculum. Furthermore, Walidah et al., (2020) concluded that mathematics learning using the Flipped Classroom model resulted in higher learning outcomes than conventional learning.

However, previous research has been dominated by studies on the influence of the Flipped Classroom on cognitive aspects, specifically learning outcomes. Studies integrating the model's influence on affective aspects, particularly self-efficacy, are relatively limited (Prastawati et al., 2023). Meanwhile, research on self-efficacy in mathematics learning generally focuses more on the relationship between self-efficacy and mathematical problem-solving ability without linking it to the implementation of the Flipped Classroom model (Nahdi, 2018). Furthermore, research examining the simultaneous impact of the Flipped Classroom on mathematics learning outcomes and self-efficacy in MTs students, particularly on Straight Line Equations, is still rare. This situation indicates a research gap that requires further investigation.

Based on these issues and research gaps, the novelty of this study lies in assessing the effectiveness of the Flipped Classroom model on two aspects of learning simultaneously: mathematics learning outcomes as a cognitive aspect and self-efficacy as an affective aspect in the context of MTs students' mathematics learning. This research is based on the constructivist perspective, which emphasizes that students actively construct their knowledge through learning experiences, and Bandura's self-efficacy theory, which states that an individual's belief in their abilities can influence motivation, persistence, and success in completing tasks.

Therefore, this research focuses on the implementation of the Flipped Classroom learning model as an effort to improve mathematics learning outcomes and self-efficacy of eighth-grade students at MTsN 10 Agam in the topic of Straight Line Equations. The purpose of this study is to analyze the effect of the Flipped Classroom model on mathematics learning outcomes and self-efficacy. The results of this study are expected to provide an empirical contribution regarding the effectiveness of the Flipped Classroom model in creating more meaningful mathematics learning, thereby not only improving students' academic achievement but also strengthening students' confidence and independence in learning mathematics.

METHODS

This study used a quantitative approach with a quasi-experimental approach. The study was conducted at MTsN 10 Agam in the even semester of the 2025/2026 academic year, from January to February 2026, for approximately six weeks. This included preparation, treatment, and data collection. The study aimed to determine the effect of implementing the Flipped Classroom learning model on mathematics learning outcomes and student self-efficacy in the Straight Line Equation topic.

The research design used was a Posttest-Only Control Group Design, an experimental design involving two groups without a pretest. The first group, the experimental class, received treatment using the Flipped Classroom model, while the second group, the control class, received conventional learning. After the entire learning process was completed, both groups were given a posttest to measure mathematics learning outcomes and a questionnaire to assess student self-efficacy. The research design is shown in Table 2.

Table 2. Research Design: Posttest-Only Control Group Design

Class	Action	Posttest
R (Experiment)	X	O_1
R (Control)	–	O_2

Description:

R = Randomly selected classes

X = Learning using the Flipped Classroom model

O_1 = Posttest of learning outcomes and self-efficacy questionnaire for the experimental class

O_2 = Posttest of learning outcomes and self-efficacy questionnaire for the control class

The participants in this study were all eighth-grade students at MTsN 10 Agam, comprising four classes, totaling 91 students. Prior to sample selection, a population-specific test was conducted, including a normality test using the Liliefors test, a homogeneity test using the Bartlett test, and a test for equality of means using one-way analysis of variance (ANOVA). The test results indicated that the population was normally distributed, had homogeneous variance, and had equal initial abilities, thus meeting the requirements for sampling.

The sampling technique used was Cluster Random Sampling, as the sample was drawn based on class groups, not individual students. Based on the results of the drawing, class VIII.4, with 25 students, served as the experimental class, and class VIII.1, with 20 students, served as the control class.

The independent variable in this study was the Flipped Classroom learning model, while the dependent variables consisted of mathematics learning outcomes and student self-efficacy. The implementation of the Flipped Classroom model was carried out in two stages: out-of-class activities and in-class activities. In asynchronous learning, students studied instructional videos, teaching materials, and a summary of the Straight Line Equation material sent by the teacher via WhatsApp Group two days before the face-to-face lesson. Furthermore, in-class activities, students participated in active learning through group discussions, problem-based worksheets (LKPD), presentations of discussion results, and received guidance and conceptual reinforcement from the teacher. Meanwhile, learning in the control class was conducted using conventional methods through direct material delivery, example problems, and individual practice.

The research instruments used consisted of a five-item mathematics learning outcome test in the form of descriptive questions and a 30-item self-efficacy questionnaire. Data collection was conducted after the learning treatment was completed through a posttest in both classes and the distribution of the self-efficacy questionnaire. Prior to use, the instrument was pre-tested in a class outside the study sample. Validity tests using Product Moment correlation showed that all items had values $r_{calculated}$ greater than $r_{table} = 0.404$, thus being declared valid. Based on the validity category, one question was categorized as moderate, one question as high, and three questions as very high. The reliability test using the Alpha formula yielded a value (r_{11} = 0.868) in the very high category, thus declaring the instrument reliable. Analysis of the difficulty level indicated that most questions were in

the moderate category and one question was in the easy category. Meanwhile, the discriminatory power analysis indicated that two questions were in the good category and three questions were in the very good category.

The research data were analyzed using the SPSS program through several stages. The first stage was a normality test using the Liliefors test to determine whether the research data were normally distributed. The second stage was a homogeneity test using the F test to determine the equality of variance between the experimental and control classes. After both requirements were met, the hypothesis was tested using a t-test at a significance level of $\alpha = 0.05$ to determine the effect of implementing the Flipped Classroom learning model on mathematics learning outcomes and student self-efficacy.

RESULTS

1. Descriptive Statistics of Mathematics Learning Outcomes and Student Self-Efficacy

Research data were obtained from mathematics learning outcome tests and self-efficacy questionnaires administered to students after the learning process was completed. Descriptive statistics of the research data are presented in Table 3.

Table 3. Descriptive Statistics of Mathematics Learning Outcomes and Student Self-Efficacy

Variables	Class	N	Minimum	Maximum	Mean	SD
Mathematics Learning Outcomes	Experiment	25	60	92	78,88	8,99
	Control	20	30	75	57,80	12,58
Self-efficacy	Experiment	25	-	-	99,04	-
	Control	20	-	-	92,70	-

Source: Processed Data 2026

Table 3 shows that the average mathematics learning outcomes of students in the experimental class (78.88) were higher than those in the control class (57.80). Similarly, for the self-efficacy variable, the average score of students in the experimental class (99.04) was higher than that of the control class (92.70). These results indicate that students who participated in learning using the Flipped Classroom model tended to have better mathematics learning outcomes and self-efficacy than students who participated in conventional learning.

2. Prerequisite Analysis Test

Before testing the hypotheses, normality and homogeneity tests were conducted on the research data. The test results are presented in Table 4.

Table 4. Summary of Prerequisite Analysis Test Results

Variable	Normality Test	Criteria	Result	Conclusion
Learning Outcome	Homogeneity	Sig. > 0,05	0,077 (Experiment) 0,250 (Control)	Normal
	Normality	$F_{count} < F_{table}$	1,96 < 4,06	Homogeneous
Self-Efficacy	Homogeneity	Sig. > 0,05	0,560 (Experiment) 0,569 (Control)	Normal
	Normality Test	$F_{count} < F_{table}$	1,612 < 2,11	Homogeneous

Source: Processed Data 2026

Based on Table 4, all research data have a significance value greater than 0.05 and the calculated F value is smaller than the F table. Therefore, the mathematics learning outcomes and self-efficacy data are normally distributed and have homogeneous variance, thus meeting the requirements for hypothesis testing using the t-test.

3. Hypothesis Testing

After the data met the assumptions of normality and homogeneity, the hypothesis was tested using the t-test at a significance level of $\alpha = 0.05$. The results of the hypothesis testing are presented in Table 5.

Table 5. Summary of Hypothesis Testing Results

Variable	t_{count}	t_{table}	df	Sig. (2-tailed)	Decision
Mathematics Learning Outcomes	4,876	1,68	43	0,000	H_0 rejected
Self-efficacy	1,70	1,68	43	0,000	H_0 rejected

Source: Processed Data 2026

Note: $df = n_1 + n_2 - 2 = 25 + 20 - 2 = 43$.

Based on Table 4, for the mathematics learning outcomes variable, the t-test value is 4.876 > t-test = 1.68, with a significance value of 0.000 <0.05. Therefore, H_0 is rejected and H_1 is accepted. This indicates that the Flipped Classroom learning model has an effect on students' mathematics learning outcomes. For the self-efficacy variable, the t-test value is 1.70 > t-test = 1.68, with a significance value of 0.000 <0.05. Therefore, H_0 is rejected and H_1 is accepted. This indicates that the Flipped Classroom learning model has an effect on students' self-efficacy. Based on the results of the hypothesis testing, it can be concluded that

the Flipped Classroom learning model has a positive effect on mathematics learning outcomes and self-efficacy of class VIII students at MTsN 10 Agam.

DISCUSSION

1. The Effect of the Flipped Classroom Learning Model on Students' Mathematics Learning Outcomes

The data analysis results indicate that the implementation of the Flipped Classroom learning model has an effect on the mathematics learning outcomes of eighth-grade students at MTsN 10 Agam. This is evidenced by the t-test results, which show a value t_{count} =4.876 greater than t_{table}=1.68 at a significance level of 0.05, thus H_0 is rejected and H_1 is accepted. Furthermore, the average student learning outcome in the experimental class, at 78.88, is higher than the control class's score of 57.88. These findings indicate that learning using the Flipped Classroom model provides students with the opportunity to gain initial understanding through independent learning before face-to-face activities, allowing classroom time to be utilized for more student-centered activities (Moniz & Nuryani, 2024).

This improvement in learning outcomes can be explained by the characteristics of the Flipped Classroom model, which integrates independent learning activities through digital media and active learning activities in the classroom. In the Straight Line Equation topic, students are required to understand the concept of gradient, relationships between variables, graphical representation, and contextual problem solving (Samura, 2019). Through independent learning using videos and teaching materials before class, students have the opportunity to access the material at their own pace. Furthermore, face-to-face activities are used for group discussions, problem-solving-based worksheets (LKPD), and clarification of unclear concepts. This is consistent with constructivist theory, which states that knowledge is formed through students' active involvement in the process of building understanding through learning experiences.

The findings of this study align with those of Pratiwi, (2021), who stated that the Flipped Classroom model can improve student learning outcomes by optimizing classroom time. These findings also support Rosneli et al., (2020) findings, which indicate that the learning flexibility of the Flipped Classroom model can improve student conceptual understanding. Furthermore, Hendriana, (2017) found that students who participated in learning using the Flipped Classroom model achieved better mathematics learning outcomes

compared to students who learned through conventional learning. These similar findings reinforce the idea that the implementation of the Flipped Classroom model can create a more active, flexible, and needs-oriented learning process.

The implications of these findings suggest that the Flipped Classroom model can be used as an effective alternative mathematics learning strategy to improve student learning outcomes. The use of digital media prior to face-to-face learning allows teachers to optimize class time for discussion, problem-solving exercises, and conceptual reinforcement, enabling students to gain a more meaningful learning experience.

However, this study has limitations because it was conducted only on the topic of Straight Line Equations with a relatively limited sample size. Therefore, the results cannot be generalized to all mathematics materials or to a broader student population. Future research is recommended to apply the Flipped Classroom model to other mathematics materials with different characteristics and involve a larger sample size to obtain a more comprehensive picture of its effectiveness.

2. The Effect of the Flipped Classroom Learning Model on Student Self-Efficacy

The results of the study indicate that the implementation of the Flipped Classroom learning model has an impact on the self-efficacy of eighth-grade students at MTsN 10 Agam. The t-test results show that the value t_{count}=1.70 is greater than t_{table} =1.68 at a significance level of 0.05, thus H_0 is rejected and H_1 is accepted. The analysis results using SPSS also showed a significance value of 0.000 <0.05. Furthermore, the average self-efficacy score of students in the experimental class was 99.04, higher than the control class (92.70). These results indicate that learning that provides students with opportunities for independent learning before face-to-face learning and active interaction during class activities can increase students' confidence in their abilities to complete mathematics assignments.

This increase in self-efficacy can be explained through Bandura's self-efficacy theory, which emphasizes that successful experiences (mastery experiences) are one of the main sources of building one's self-confidence. Through the Flipped Classroom model, students have the opportunity to first understand the material through learning videos, then apply that understanding in discussions and worksheet completion activities in class. Students' success in completing assignments and receiving feedback from teachers and peers provides a positive experience that can strengthen their confidence in their mathematical abilities.

Furthermore, the collaborative learning environment during group discussions also helps students reduce anxiety and increase their confidence in expressing their opinions.

The results of this study support the research of Stephanus (2025), who stated that implementing the Flipped Classroom model can improve students' self-efficacy through the use of technology and independent learning. This finding also aligns with the research of Puteri et al., (2025), which shows that self-efficacy plays a crucial role in students' success in solving mathematics problems. Furthermore, Stephanus, (2025) stated that integrating technology into learning can help improve students' affective aspects, including reducing mathematics learning anxiety and strengthening self-confidence.

The implications of this research indicate that implementing the Flipped Classroom model not only impacts cognitive abilities in the form of mathematics learning outcomes but also contributes to the development of students' affective aspects in the form of self-efficacy. Therefore, mathematics teachers can utilize this learning model as a strategy to create a more independent, interactive learning environment that supports the development of student self-confidence.

The limitations of this study lie in the relatively short treatment duration and the use of a questionnaire as a self-efficacy measurement, which relies solely on student perceptions. Future research is recommended to use a longer treatment period and combine a quantitative approach with interviews or observations to allow for a more in-depth analysis of student self-efficacy development.

CONCLUSION

Summary of Research Findings

This study shows that the implementation of the Flipped Classroom model has a positive impact on mathematics learning outcomes and student self-efficacy in the topic of Straight Line Equations. Through learning that integrates independent learning activities before face-to-face meetings and problem-solving activities during the lesson, students have broader opportunities to build a gradual and in-depth understanding of concepts. The research findings indicate that the Flipped Classroom model can support improved student cognitive achievement by optimizing classroom time for discussions, concept clarification, and solving mathematical problems. Furthermore, this model also contributes to improving students' affective aspects, particularly self-efficacy, as demonstrated by increased student

confidence in their ability to learn and solve mathematical problems. Thus, the research objective of examining the effectiveness of the Flipped Classroom on student learning outcomes and self-efficacy has been achieved, and it also demonstrates that technology-based learning can have a positive impact on students' academic and psychological development simultaneously.

Contribution to Knowledge

This research provides both practical and theoretical contributions to the field of mathematics education. Practically, the research findings reinforce the use of the Flipped Classroom model as an effective learning alternative to improve student learning outcomes and self-efficacy in conceptual mathematics materials requiring visual representation, such as Straight Line Equations. These findings can be considered by teachers in designing more student-centered learning by utilizing digital technology as a learning support tool.

Theoretically, this research adds empirical evidence regarding the relationship between the implementation of the Flipped Classroom, improved learning outcomes, and strengthened student self-efficacy. The results indicate that organizing learning that provides opportunities for independent learning before face-to-face activities can create learning experiences that support the development of academic abilities and student self-confidence in learning mathematics. Thus, this research enriches the study of the effectiveness of innovative learning models in supporting the achievement of students' cognitive and affective competencies.

Recommendations for Future Research

This research has limitations such as the use of a posttest-only control group design, the limited scope of material on Straight Line Equations, and the relatively short duration of the model's implementation. Therefore, future research is recommended to use a longitudinal or experimental design that allows for the measurement of student development over a longer period of time so that the ongoing impact of Flipped Classroom implementation can be analyzed more comprehensively.

Furthermore, future research can expand the research context to include different educational levels, mathematics materials, and student characteristics to increase the generalizability of the findings. Researchers are also advised to examine other variables that could potentially influence the effectiveness of Flipped Classroom, such as initial mathematics abilities, learning motivation, digital literacy, independent learning skills, and

family environmental support. Expanding research by including these variables is expected to provide a deeper understanding of the factors that support the successful implementation of Flipped Classroom.

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