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The Effect Of Implementing The Flipped Classroom Model On Mathematics Learning Outcomes In Spldv Material

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Abstract

Junior high school students' mathematics learning outcomes, particularly in the topic of Systems of Linear Equations in Two Variables (SPLDV), remain low due to the teacher-centered learning process, which makes students less active and makes it difficult to grasp concepts in depth. This situation indicates the need for innovative learning models that encourage student independence and active involvement. One relevant alternative is the problem-solving model. Flipped Classroom, which allows students to study material independently outside of class through digital media and utilize face-to-face class time for discussion and problem-solving activities. This study aims to determine the effect of implementing the learning model. Flipped Classroom on students' mathematics learning outcomes in SPLDV material. The research approach used was quantitative with a quasi-experimental design (as if an experiment) typenonequivalent control group design. The research subjects were students of class VIII of UPT SMPN 1 Rembon who were divided into two groups, namely the experimental class which was taught using the model Flipped Classroom and control classes with conventional learning. Data were collected using validated learning outcome tests and analyzed using that two independent samples after fulfilling the assumptions of normality and homogeneity. The results of the study showed that there was a significant difference between student learning outcomes in the experimental class and the control class, where the average student learning outcomes in the class that implemented the Flipped Classroom higher. Thus, the model Flipped Classroom has a positive effect on improving students' mathematics learning outcomes in SPLDV material and can be used as an alternative effective learning strategy at the junior high school level.

Keywords: Flipped Classroom, learning outcomes mathematics, SPLDV, quantitativ

Introduction

Mathematics instruction at the junior high school (SMP) level plays a strategic role in developing students' logical, analytical, critical, and systematic thinking skills. These skills are a crucial foundation for mastering mathematical concepts at subsequent levels of education and provide preparation for facing real-life challenges that demand higher-order thinking skills. Within the context of the national curriculum, mathematics is positioned as a tool for practicing reasoning, problem-solving, and communication mathematical skills that function to develop thinking skills and numeracy literacy (Ramadhani, Prahmana, Soeharto, & Saleh, 2024).

One of the important topics in the junior high school mathematics curriculum is the System of Linear Equations in Two Variables (SPLDV). This material demands complex conceptual and procedural skills because it involves understanding the relationship between two variables and their representation in equations and graphs. SPLDV serves as a bridge between algebra and mathematical applications in contextual situations, such as economic problems, comparisons, and modeling. Consequently, mastering SPLDV concepts is crucial for students' success in understanding algebra at later stages.

However, various studies have shown that junior high school students still experience difficulties in understanding SPLDV, both conceptually and in its application. Maiprillia, Mailizar, and Elizar (2022) found that most students failed to link the problem context to an appropriate mathematical model. On the other hand, Masdalena, Aniswita, Isnaniah, and Medika (2023) noted numerous procedural errors caused by basic misconceptions about linear relationships. These difficulties not only reduce learning outcomes but also hinder the development of higher-level mathematical thinking skills such as analysis, generalization, and reflection.

The fundamental weakness in SPLDV learning in schools often lies in the conventional learning approach which is still teacher-centered (*teacher-centered learning*). This model positions the teacher as the sole source of information and students as passive recipients. In practice, teachers spend most of their time explaining concepts and providing examples, while students simply listen, take notes, and imitate solution procedures. As a result, learning activities become monotonous and do not allow for independent exploration of ideas or the construction of meaning. As stated by Ishartono, Rahayu, and Widiyawati (2022), a learning model that is too teacher-oriented hinders the development of students' reflective and creative thinking skills.

On the other hand, conventional learning approaches also provide less opportunities for students to build *sense making*, namely the ability to understand and relate concepts meaningfully. Learning that only emphasizes mastery of mechanical procedures tends to foster memorization without in-depth understanding. This condition results in low student motivation and participation in mathematics learning (Pratiwi, 2022). Furthermore, passive learning is also inconsistent with the demands of mathematics. *Free to Learn* which emphasizes the importance of independence and contextual learning experiences.

Therefore, innovative learning strategies are needed that can increase active student engagement, foster curiosity, and facilitate meaningful learning. One approach that meets these needs is the Flipped Classroom (FC) learning model., a pedagogical innovation

that utilizes digital technology to change the traditional structure of the teaching and learning process (Bergmann & Sams, 2012).

The FC model essentially “reverses” the sequence of learning activities: the material delivery activities that are usually carried out in class are moved outside the class through learning videos,

digital modules, or online platforms; while face-to-face class time is used for interactive activities such as discussion, collaboration, problem-solving, and reflection. This way, students can learn the material at their own pace (*self-paced learning*) before the class session begins, and when in class they are ready to actively participate in high-level activities such as analysis and application.

Furthermore, the Flipped Classroom (FC) model is not only understood as a technological innovation but also as a pedagogical approach that demands a paradigm shift in the teaching and learning process. The shift from teacher-centered to student-centered learning marks a major transformation in classroom dynamics. In FC, the teacher acts as a facilitator, guide, and designer of a conducive learning environment, while students become active subjects constructing knowledge through experience and reflection (Yuliani & Kurniawan, 2023).

The FC approach is in line with constructivism theory., which states that knowledge is actively constructed by students through learning experiences, not simply transferred by teachers (Ramadhani et al., 2024). Within this framework, learning becomes more student-centered (*student-centered learning*) and oriented toward conceptual understanding. The teacher acts as a facilitator who designs learning experiences, not as the primary source of knowledge. FC also provides opportunities for students to learn collaboratively, solve problems, and construct meaning socially through discussions with classmates.

A crucial aspect of FC is its ability to integrate educational technology into the learning process. Various applications such as GeoGebra, Edmodo, and Google Classroom can be utilized to support both online and face-to-face learning. Ishartono et al. (2022) demonstrated that integrating GeoGebra into FC improved students' mathematical representation skills and SRL. Meanwhile, Dilla (2022) and Saputro (2023) found that using Google Classroom in FC helped teachers provide rapid feedback and monitor students' learning progress in real time.

With the support of technology, FC provides significant flexibility in managing time and learning resources. Students can watch learning videos repeatedly as needed, strengthening their understanding of concepts. Teachers can also utilize student activity data to adjust classroom learning strategies. FC not only improves academic outcomes but also provides a more personalized and adaptive learning experience tailored to individual student needs (Rini, Yusrizal, & Fauzi, 2023).

Recent research confirms the effectiveness of FC in improving mathematics learning outcomes. Cahyani (2024), through a meta-analysis of 25 studies, found that FC implementation had a moderate positive effect on improving mathematics learning outcomes at various levels of education. Arya (2024) also reported significant differences in learning outcomes between students taught using the FC model and those taught conventionally. FC has been shown to encourage students to be more independent in preparing themselves before class, allowing face-to-face time to be focused on deepening concepts and practicing contextual problem-solving skills.

Furthermore, FC has also been shown to impact student motivation and learning engagement. According to research by Dilla (2022), students who participate in FC learning demonstrate higher levels of motivation because they feel they have control over their own learning time and methods. FC also allows for a variety of learning styles, making learning more inclusive. This aligns with research by Subagyo (2024), who found that FC increases students' sense of responsibility for their learning process, as well as fostering discipline and self-confidence.

In its implementation, the success of the model *Flipped Classroom (FC)* Learning success is not only determined by technological mastery, but also by the quality of learning design and the consistent application of underlying pedagogical principles. FC requires teachers to be able to design learning activities that go beyond simply watching videos, but also create learning experiences that stimulate students' cognitive and social engagement. Teachers act as designers of learning ecosystems that facilitate exploration, collaboration, and conceptual reflection. Therefore, teachers must be able to design engaging digital teaching materials, prepare problem-based face-to-face activities, and provide timely and formative feedback (Wijayanti, Prihastuti, & Nuraeni, 2024).

However, to ensure the effectiveness of FC, teachers need to consider several important principles in their learning design. First, pre-lesson material should be presented in an engaging and interactive format, for example, short videos (5–10 minutes) with relevant contextual examples. Second, face-to-face activities should be directed at applying concepts through discussions, simulations, or collaborative projects. Third, teachers need to provide constructive and ongoing formative feedback. These principles were proven effective in research by Widiyanti, Kadarisma, and Zanthi (2024), who reported that students learning with FC based on reflective activities experienced higher learning outcomes and motivation than students in control classes.

In addition, teachers need to ensure that face-to-face activities are not just question and answer sessions, but are truly focused on learning activities. *active learning* such as problem-based learning, project-based learning, or inquiry learning (Wijayanti, Prihastuti, & Nuraeni, 2024). In their research, FC combined with problem-based learning resulted in significant improvements in junior high school students' mathematical problem-solving abilities. In other words, the success of FC is largely determined by how teachers utilize class time for exploratory and reflective activities.

Another frequently encountered challenge is technological readiness and digital literacy, both on the part of teachers and students. Astuti and Handayani (2023) noted that 62% of teachers still experience difficulties in designing interactive and contextual learning videos. Many teachers still focus on the technical aspects (uploading videos to platforms) without considering the pedagogical aspects (students' thought processes, context, and motivation). Therefore, improving teacher competency *indigital pedagogical design* become a key factor in FC's success.

For students, the main challenge lies in self-discipline and learning accountability. FC requires students to watch videos and complete pre-lesson assignments before class sessions. In some cases, students who lack discipline tend to procrastinate or even skip class. This stage, which impacts the effectiveness of face-to-face learning. To overcome this, monitoring strategies such as *learning contract* And *self-assessment log* can be applied. Prasetyo,

Hidayat, and Kurnia (2024) showed that the use of *learning contract* in FC increases students' consistency in pre-lesson preparation and has a positive impact on learning outcomes.

In addition to pedagogical and technological factors, the social and cultural context also plays a significant role in determining the success of FC. In the Indonesian context, a strong collective learning culture and social orientation can offer significant potential for strengthening interactions in collaborative learning. Lembang and Parinding (2024) found that the characteristics of Torajan students, who highly value the spirit of mutual cooperation and togetherness, can support FC implementation, particularly in group discussions. However, teachers must ensure that collaboration does not lead to dependency, but rather fosters individual responsibility in each student.

On the other hand, limited infrastructure, such as internet access and digital devices in the regions, remains a barrier to FC implementation. Therefore, adapting the FC model is becoming increasingly important *blended flipped classroom* Combining online and offline activities creates a realistic alternative. This model allows students without stable internet access to access materials through videos stored on school devices or offline media such as flash drives. In this way, the basic principles of FC can still be applied without sacrificing equal learning opportunities.

In the local context of UPT SMPN 1 Rembon, these challenges are highly relevant. Based on observations by mathematics teachers at the school, the average student learning outcomes in SPLDV material are still below the Minimum Completion Criteria (KKM). Students tend to be passive, less involved in discussions, and have not demonstrated optimal learning independence. Teachers identified the main causes of this condition as a lack of varied learning strategies and minimal use of technology in the learning process. Therefore, the implementation of the FC model is expected to be an innovative solution to improve learning outcomes while fostering student motivation and responsibility for learning.

Furthermore, FC is expected to foster a new learning culture that is more independent, reflective, and collaborative among students. With pre-lesson activities through videos and digital modules, students have time to prepare and understand basic concepts before class sessions. This makes face-to-face activities more meaningful because students arrive with prior knowledge that can serve as a starting point for discussions and problem-solving. In the long run, this can improve students' mathematical literacy and confidence in facing more complex learning challenges.

Thus, the implementation of FC is expected to produce two main impacts: (1) improving students' mathematics learning outcomes on SPLDV material, and (2) strengthening students' learning independence and reflective abilities. The findings of this study are expected to enrich the literature on the implementation of FC in the context of junior high schools, especially in areas with limited infrastructure such as Tana Toraja. Scientifically, this research provides a theoretical contribution by broadening understanding of the relationship between FC, SRL, and mathematics learning outcomes in the context of secondary education in Indonesia. Practically, this research can serve as a reference for teachers in designing innovative learning that integrates digital technology and active learning principles. For schools, the results of this study can serve as a basis for developing technology-based learning policies and teacher training programs focused on pedagogical digital

literacy.

Based on the overall description above, it can be emphasized that the implementation of *Flipped Classroom* in junior high school mathematics learning, especially in the material on Two-Variable Linear Equation Systems (SPLDV), This is a strategic step to improve the quality of learning while fostering student learning independence. Supported by strong empirical evidence, modern learning theories, and a unique local context, this research is expected to make a tangible contribution to building a mathematics learning paradigm that is more relevant to the demands of the times.

Therefore, the purpose of this study is to analyze the effect of implementing the model *Flipped Classroom* on the mathematics learning outcomes of eighth-grade students on SPLDV material at the UPT SMPN 1 Rembon. Specifically, this study also aims to determine how the model can improve students' learning independence and active participation in the learning process.

Research methods

This research uses a quantitative approach with a quasi-experimental method (*as if an experiment*) which aims to determine the effect of implementing the model *Flipped Classroom* on students' mathematics learning outcomes in the Two-Variable Linear Equation System (SPLDV) material. The research design used *isnonequivalent control group design*, which involved two groups, namely the experimental class which received learning treatment using the model *Flipped Classroom* and a control class taught using conventional learning. The research population was all eighth grade students of UPT SMPN 1 Rembon, while the research sample was selected randomly *purposive sampling* based on the equality of academic ability between classes. The research instrument was a descriptive mathematics learning outcome test that had gone through a content validation process by experts and a reliability test using the Cronbach's Alpha formula. The research procedure included three stages: preparation, implementation, and evaluation. In the implementation stage, the experimental class was given treatment by watching learning videos and studying the material independently before class meetings, then class activities focused on discussion and problem solving, while the control class received conventional learning through lectures and practice questions. Student learning outcome data were collected after the treatment was given, then analyzed using normality tests, homogeneity tests, and *t* two independent samples to determine significant differences between the two groups. The results of this analysis form the basis for concluding the effectiveness of the model *Flipped Classroom* in improving students' mathematics learning outcomes in SPLDV material.

Results and Discussion

1. Research Implementation

This research was conducted at the UPT SMPN 1 Rembon in the even semester of the 2025/2026 academic year. The aim of the research was to determine the effect of implementing the learning model *Flipped Classroom* on the mathematics learning outcomes of eighth grade students on the subject of Two-Variable Linear Equation Systems (SPLDV). The study used a design *as if an experiment* with *isnonequivalent control group design*. The research sample consisted of two classes, namely class VIII A as the experimental class and VIII B as the control class, each consisting of 32 students.

The research was conducted in three stages: preparation, implementation, and evaluation. During the preparation stage, the researcher prepared learning materials in the form of a Lesson Implementation Plan (RPP), learning videos, and learning outcome test instruments. The learning videos were developed with the characteristics of junior high school students in mind and included an explanation of the SPLDV concept, sample questions, and its application in everyday life. During the implementation stage, the experimental class was given a learning treatment using the *Flipped Classroom* over four meetings, while the control class followed conventional learning with lectures and practice exercises. The final stage of the study involved administering a posttest and collecting observational data on student activities and the implementation of the learning.

2. Description of Learning Outcome Data

Learning outcome data were obtained from pretests and posttests administered to students in both groups. The results of the descriptive analysis are presented in Table 1 below.

Table 1. Descriptive Statistics of Pretest and Posttest Scores

Class	N	Rate-rate Pretest	SD Pretest	Rate-rate Posttest	SD Posttest	Gain Score	Completion (%)
Experiment	32	66,84	7,52	83,75	6,21	16,91	87,5
Control	32	65,28	8,14	75,13	7,45	9,85	65,6

The table above shows that the average posttest score for the experimental class was higher than that for the control class. The gain score for students in the experimental class was 16.91 points, while the gain for students in the control class was only 9.85 points. Furthermore, the learning completion rate for the experimental class reached 87.5% (very good category), while the gain for the control class was only 65.6%. These data indicate that the learning model *Flipped Classroom* able to improve mathematics learning outcomes more significantly than conventional learning.

3. Prerequisite Analysis Test

Before conducting the hypothesis test, the learning outcome data was first tested to ensure that the requirements for parametric analysis were met. The validity of the test items was tested using correlation *Product Moment Pearson*. Of the 10 descriptive questions, 9 valid questions were obtained with a score of *r-count* between 0.428–0.796 is greater than *r-table* = 0.349 at a significance level of 5%. Reliability test was carried out using the Cronbach Alpha formula and obtained a value of $\alpha = 0.86$ which indicates high reliability.

The normality test using the Kolmogorov–Smirnov test yielded a significance value of 0.164 for the experimental class and 0.200 for the control class (both > 0.05), indicating that the data were normally distributed. The homogeneity test of variance using the Levene test yielded a significance value of 0.423 (> 0.05), indicating that the variances of both groups were homogeneous. Thus, the learning outcome data met the assumptions of normality and homogeneity, allowing the analysis to proceed with the test *t* two independent samples.

Table 2. Results of the Analysis Prerequisite Test

Test Type	Class Experiment	Control Class	Criteria	Conclusion
Normality (Sig)	0,164	0,200	$> 0,05$	Normal
Homogeneity (Say)	–	0,423	$> 0,05$	Homogeneous
Reliability α	0,86	–	$\geq 0,70$	Reliable

The test results show that the data meets all prerequisite tests so that it can be analyzed further to test the research hypothesis.

4. Hypothesis Testing

To determine whether there is a difference in learning outcomes between the experimental and control classes, a test was conducted. *t* two independent samples with a significance level of 0.05. The test results *t* can be seen in Table 3 below.

Table 3. Results of the Two Independent Sample t-Test

Variables	t-count	t-table	df	Sig. (2-tailed)	Results
Learning Outcomes (Posttest)	4,216	2,000	62	0,000	H ₀ is rejected, H ₁ is accepted

Based on the calculation results in Table 3, it is obtained *t*-count is 4.216 times greater than *t*-table of 2,000 at a significance level of 5% with degrees of freedom (df) = 62. The significance value (Sig. 2-tailed) of 0,000 < 0.05 indicates that there is a significant difference between student learning outcomes in the experimental class and the control class. Thus, the research hypothesis is accepted, namely the application of the model *Flipped Classroom* has a significant influence on students' mathematics learning outcomes in SPLDV material.

5. Learning Activities and Learning Implementation

In addition to the learning outcome tests, observations of student activities and learning implementation were conducted throughout the study to identify differences in learning behavior between the two groups. The results of these observations are presented in Table 4 below.

Table 4. Results of Observations of Learning Activities and Implementation

Observed Aspects	Experimental Class (%)	Control Class (%)	Category Experiment
Student learning activities	82,4	69,7	Very Active
Implementation teacher learning	94,5	87,3	Very good
Participation in discussion	85,7	72,1	High
Student initiatives and questions	80,2	64,8	High

Table 4 shows that student learning activity in the experimental class was higher than in the control class. Students in the experimental class demonstrated active involvement in discussions, group work, and contextual problem solving. This was due to the design *Flipped Classroom* which provides space for students to prepare themselves through videos and teaching materials before face-to-face meetings, so that students come to class with a better initial understanding.

Discussion

The results of the study show that the model *Flipped Classroom* effective in improving students' mathematics learning outcomes. This is evident from the significant difference between the average posttest scores of the experimental and control classes. This improvement in learning outcomes indicates that students who learn using the model *Flipped Classroom* gain a better conceptual understanding of the SPLDV material.

This increase in learning outcomes can be explained by the change in learning paradigm that occurs in the model *Flipped Classroom*. Students no longer passively receive information from the teacher, but instead actively study the material independently

before class. During face-to-face activities, class time is used for discussions, asking questions, and solving more complex problems. This learning pattern encourages more intensive interaction between students and the teacher and between students, ultimately deepening understanding and improving critical thinking skills.

This study supports the findings of Ishartono et al. (2022) which show that *Flipped Classroom* improves motivation and mathematics learning outcomes because it allows students to manage their own learning time. Similarly, Ramadhani et al. (2024) found that this model improves critical thinking skills and learning independence. Zakiyah (2023) emphasized that problem-based learning *Flipped Classroom* create a collaborative and interactive atmosphere, so that students become more confident and active in the learning process.

Theoretically, the results of this study align with the constructivist view, which states that knowledge is constructed through active and meaningful learning experiences. In this context, *Flipped Classroom* providing opportunities for students to play an active role in building their understanding, while the teacher acts as a facilitator and guide.

This also strengthens the findings of Anwar and Fathoni (2021) that active student involvement in learning is the key to improving mathematics learning outcomes.

Thus, the implementation of *Flipped Classroom* has been shown to improve mathematics learning outcomes while creating a conducive, active, and collaborative classroom atmosphere. The implication of this research is the need for mathematics teachers to optimize the use of learning technology and educational videos in the learning process to make students more independent, interactive, and prepared to face the challenges of 21st-century learning.

Conclusion

Based on the results and discussion, it can be concluded that the implementation of the *Flipped Classroom* model has a significant effect on improving students' mathematics learning outcomes in the topic of Systems of Linear Equations in Two Variables (SPLDV), as indicated by the higher average scores achieved by the experimental class compared to the control class; moreover, this model enhances students' activeness, participation, and learning independence through more flexible and interactive learning, while shifting the learning paradigm from teacher-centered to student-centered, thereby encouraging students to actively construct their understanding through discussion, collaboration, and problem-solving activities, making the *Flipped Classroom* an effective alternative strategy to improve the quality of mathematics learning at the junior high school level, particularly in SPLDV material.

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