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EXPERIMENTATION OF THE FLIPPED CLASSROOM LEARNING MODEL AND INQUIRY LEARNING ON LEARNING ACHIEVEMENT REVIEWED FROM THE LEARNING STYLES OF SMP N 1 SUKODONO STUDENTS

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ABSTRACT

This research aims to explore the impact of implementing inquiry learning and flipped classroom models on mathematics learning achievement, considering students' learning styles. The researcher employed a quantitative method through a 2x3 factorial experiment design. Data processing and analysis were conducted using a two-way ANOVA, followed by a post-ANOVA pairwise comparison using the Tukey HSD method. The population consisted of all students of SMP Negeri 1 Sukodono in the eighth grade of the academic year 2023/2024. A total of 27 students from class VIII D were assigned as experimental group I, and 27 students from class VIII F were assigned as experimental group II, each selected as samples for the study using cluster sampling or the random sampling method. Based on the results of the two-way ANOVA, it was found that there is a difference between the flipped classroom and inquiry learning models in improving students' learning achievement. The flipped classroom model was proven to be more effective than the inquiry learning model in enhancing students' mathematics learning achievement, with an average score of 75.356. There is an influence of learning styles on students' learning achievement; visual learning style was found to be better in improving students' learning achievement compared to auditory or kinesthetic learning styles. There is an interaction between the flipped classroom and inquiry learning models regarding learning achievement.

Keywords: Flipped Classroom, Inquiry Learning, Learning Achievement, Learning Style

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PRELIMINARY

In an era of increasingly advanced technology, it has produced major transformations in a variety of human lives, including education. Education is seen as a means for achieving the goals of growth and development of the nation. Education is an essential element that a country needs in order to increase its intelligent and qualified

human resources (Darmuki & Hariyadi, 2019). Given how important the role of education is in everything, we must consider and monitor how education in Indonesia will develop. If we look at it, education in Indonesia is beginning to face real problems about how to improve the quality of education to be better, with the goal that all the ongoing processes can deliver outputs capable of competing in global competition.

The Indonesian government has been striving continuously to improve the quality of education by addressing issues such as enhancing the availability of school facilities, improving the quality of educators, and making curriculum changes or improvements. However, unfortunately, these efforts and actions remain overarching and broad, so they can be considered ineffective when applied to address problems that occur within the classroom, such as when addressing students' learning problems in understanding the material. Riani et al., (2017) revealed that, regardless of how comprehensive and high-quality the curriculum is, if teachers and students do not implement or implement it correctly in the classroom, learning will not be efficient.

According to Nurcahyo & Sudibyo (2020), during the learning process, a teacher not only strives to convey information or explanation to students, but teachers should also encourage them to be active and creative and have a strong sdesire to improve their abilities, given that many students believe that math lessons are difficult to understand. It happened because the teacher used the wrong teaching method. They tend to use inappropriate strategies or approaches and make lessons difficult for students to understand. Since the material taught differs from the student's level of ability, a teacher should pay more attention to the technique of delivery of material that is tailored to the needs of each student.

Saragih et al. (2021), stated that the learning model is understood as a structural form of conceptual nature, presenting an overview of the arranged steps in controlling the learning phases of students in order to achieve the desired learning objectives. This model is a guideline for designers and educators in planning effective learning-teaching activities to improve learning performance, increase learning motivation, and create a comfortable learning atmosphere. Students have the opportunity to think critically, talk, collaborate, and apply what they learn in a participatory learning model. Then the learning model is a tool to help students learn more enthusiastically and improve their thinking skills.

Based on observations in the 1st State School, Sukodono Sragen obtained results that teachers use general or conventional learning methods in teaching mathematics, i.e., one-way methods (*ceramah*). Less diverse and teacher-focused methods will only make

students minimally motivated and passive while studying. This causes students to get bored easily and lack interest in learning activities. Moreover, learning models that do not encourage collaboration and discussion among students can impede active learning, prevent the exchange of ideas, and reduce students' ability to work in teams. In response, practitioners in education have developed a variety of constructivist learning models, including the flipped classroom and inquiry learning models. Both models have been tested to enhance the role of students in learning so that they can produce the best results.

The flipped learning model, in principle, has a learning flow that is the opposite of the conventional learning model, wherein the conventional learning model, the material is introduced in the classroom (Ishartono et al., 2022), while homework is done in the classroom by group discussion and with the instructions of the teacher (Hastuti, 2020). Flipped classroom claims to be advantageous due to many reasons (Shukla & Mcinnis, 2021), this learning model transforms the role of the teacher as a material provider in the classroom into that of a facilitator, guiding students to understand the material independently. Students will receive learning materials through video, reading books, or technology-based materials before the lesson begins. Technology can provide positive benefits when used in learning through video learning. Using mathematics learning videos is expected to help students gain relevant information and knowledge, so that technology becomes a very useful means in the world of education and can enhance our insight. According to Mirlanda et al. (2019), it is known that flipped classrooms allow teachers to interact actively and effectively as well as communicate with students to facilitate their understanding of concepts and accommodate each student's ideas. The statement is in line with a study conducted by Syajili & Abadi (2021), with the findings that flipped classrooms proved effective in improving the conceptual understanding and confidence of pupils. Meanwhile, Hamidah & Kusuma (2021), argue that the flipping classroom accessed via the internet not only improves student learning interest but also improves learning outcomes. In the context of mathematics learning, this model has also been shown to improve students' mathematical, affective, and cognitive abilities as students get higher cognitive challenges in applying, analyzing, synthesizing, and performing evaluations in the classroom.

The learning model of inquiry learning, Romiyansah et al. (2020), states that the model is effectively applied to improve students' understanding of mathematics because it encourages students to learn independently, where they discover and investigate based on a given situation or phenomenon. The primary goal is for students to develop their

knowledge, acquire an objective, honest attitude, and have a strong desire to learn more. In this model, students are invited to explore knowledge, ask questions, and find answers through discussions and experiments. Nurkomaria (2021), in his research, it is found that inquiry learning has a positive impact on the ability of students in the average score of learning achievement. The findings are in line with the research, Sari et al. (2023), that suggests that the inquiry proved effective in adding to students' understanding of mathematical learning. Through discovery activities in learning inquiry, students have the opportunity to train their skills in mastering the stage of problem solving (Supriyati & Utama, 2015). In this model, the teacher is not the primary source of knowledge that provides information to the student but plays a role in facilitating the student and guiding the student to find knowledge through all their own efforts.

Then another problem that often occurs is the different styles of life learning. Of course, students with a variety of backgrounds have a learning style that matches their personalities; for example, they are interested in all learning styles. Not everyone has the same learning style, even when they go to school in the same place, in one class, or even in one family (Hafizha et al., 2022). Thus, a style that does not fit the student's personality can affect the level of understanding and application of the ideas taught. Therefore, teachers should identify preferences for learning styles and apply methods to learn properly. Learning style preferences can also change over time, so by considering different learning styles, all the teaching materials, classroom environments, methods, and strategies can be prepared accordingly. Shamsuddin & Kaur (2020), according to Papilaya & Huliselan,s One of the key causes of student learning success is also influenced by their learning style. In a study Wibowo (2016), the use of learning styles is said to improve student learning performance.

To recognize and overcome such situations, it is necessary to find new learning methods that are adapted to the needs of students and in line with the materials to be taught. Learning methods like flipped classroom and inquiry have proven to be effective in improving student performance. Although there is still not much research to dig into the influence of the method on the different learning styles of students, this is precisely what the authors want to choose the title of and become a study aimed at digging some information, such as: (1) students who are treated to learning flipped classroom and inquiry learning, which achieves better learning performance? (2) Students treated with auditorial, visual, or kinesthetic learning styles, which achieved better learning performance? (3) Was

there an interaction found between the learning model and the learning style against the student's learning performance in mathematics subjects?.

METHODS

This survey was conducted at the 1st State Primary School of Sukodono Sragen in the 8th grade in the first semester of the 2023/2024 academic year. This study uses a quantitative approach and includes experimental investigations aimed at studying a relationship between two or more variables, in a group of experiments then compared to a control group that did not receive treatment (Darmawan, 2013).

This research population is the entire students of the eighth grade of the State High School 1 Sukodono in the academic year 2023/2024, which consists of eight classes. In the sample process, the researchers used a random sampling system with the results of class VIII D students with a total of 27 students included in experiment class I, then class VIII F students with 27 students involved in experiment II. The research project uses factorial 2x3, which will be presented in the table below:

Table 1. Research Factorial Design

Learning Model	**Learning Style**		
	Visual (b_1)	Auditor (b_2)	Kinestetik $(\boldsymbol{b_3})$
Flipped Classroom(a_1)	(a_1b_1)	(a_1b_2)	$(\boldsymbol{a_1b_3})$
Inquiry Learning (a_2)	(a_2b_1)	(a_2b_2)	$(\boldsymbol{a_2b_3})$

This research has independent variables, namely learning models and learning styles. Then there are variables that are bound or dependent on student learning achievements. The student performance test and the learning style test are instrumental, as is the five-question description test, whereas the student style test includes 30 statements accompanied by four choices of answers: Very Agree (SS), Very Agreed (S), Disagree (TS), and Very Disagreed. (STS).

Data processing and analysis processes, including: 1) validity and realisticity of tests and racket questions 2) Rehabilitation tests include normality and homogeneity tests; 3) Hypothesis testing using two-way variant analysis (ANOVA) and continued with post-

ANOVA further tests using double comparison tests to find comparisons of learning models using Flipped Classroom and Inquiry Learning to student learning achievements reviewed in terms of student learning styles.

The next step is to test the prerequisites of the analysis using the normality test and the homogenity test. In data analysis using variance analysis (ANOVA), two cell pathways are not equal, so the hypothesis can be structured as follows:

Hypothesis 1

H_{0A} : There is no influence of flipped classroom learning and inquiry learning on learning achievement.

H_{1A} : There is an influence of flipped classroom learning and inquiry learning on learning performance.

Hypothesis 2

H_{0B} : There is no influence of learning style on learning achievement.

H_{1B} : There is an influence of learning styles on learning achievement.

Hypothesis 3

H_{0AB} : There was no interaction between the learning model of inquiry learning and the flipped classroom with the student's learning style of anticipated learning achievement.

H_{1AB} : There is an interaction between the learning model of inquiry learning and the flipped classroom with the student's learning style of anticipated learning achievement.

RESULT AND DISCUSSION

The dependent variable in this study is the test of students' mathematical learning achievement, focusing on the material of the linear equation system of two variables. Meanwhile, the independent variable data consist of a questionnaire assessing students' learning styles. Experimental class I comprised 27 students from class VIII D who underwent treatment using the flipped classroom learning model, whereas experimental class II included 27 pupils from class VIII F who received treatment based on the inquiry learning model. The study employed a two-way analysis of variance technique with non-equal cell sizes and a significance threshold of 5%. Prior to this analysis, it was necessary to assess the prerequisites for variance analysis, including conducting a normality test using the Shapiro-Wilk method and a homogeneity test using the Levene Statistical method for the relevant population.

Before conducting the learning performance test on the students, the questions are first validated to determine whether they are suitable for testing or not. Table 2 will present the results of the validity test as follows:

Table 2. Validity Details

Question Number	r_{table}	r_{count}	Description
1	0,707	0,914	Valid
2	0,707	0,914	Valid
3	0,707	0,965	Valid
4	0,707	0,965	Valid
5	0,707	0,965	Valid

Based on the results of the validity testing of the items above, the value of $r_{value} > r_{table}$; therefore, all five items are considered valid. After testing the instrument items and confirming their validity, the first step before conducting the research is to test the normality and homogeneity of the midterm test scores as pretest scores from both classes. Normality testing, as a prerequisite for the two-way ANOVA, is used to evaluate whether the data distribution or scores within the classes follow a normal distribution or not. On the other hand, homogeneity testing is employed to demonstrate that both classes originate from populations with equivalent variances. The results are presented in the following table:

Table 3. Table of Results of Normality Test Students' Learning Achievement

	Learning Model	Shapiro-Wilk		
		Statistic	Df	**Sig.**
learning achievement	Flipped Classroom	.969	**27**	**.585**
	Inquiry Learning	.929	**27**	**.066**

Table 4. Table of Students' Learning Performance Homogenity Test Results

Levene Statistic	df1	df2	Sig.
1.187	1	52	.281

Based on the results of the normality testing, the significance value (Sig.) for experimental class I is 0.585 (sig. > 0,05), and for experimental class II, is 0.066 (sig. > 0,05). This indicates that the students' learning achievement scores from both classes follow a normal distribution. Meanwhile, based on the homogeneity test results, the

significance value (Sig.) = 0,281 (sig. > 0,05), indicating that the students' learning achievement scores are homogeneous. Since both classes are normally distributed and homogeneous, they can be used as samples in the research.

The prerequisite test has been met, followed by a two-way variant analysis test with a significance of 0,05 to determine whether there is a difference in the mathematical learning performance of students taught using the flipped classroom model compared to inquiry learning, see the table below:

Table 5. Two-way Variance Analysis Test Results

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	7957.834[a]	5	1591.567	9.011	.000
Intercept	188317.186	1	188317.186	1.066E3	.000
Learning Model	1837.423	1	1837.423	10.403	.002
Learning Style	1881.466	2	940.733	5.326	.008
Learning Model* Learning Style	1424.199	2	712.100	4.032	.024
Error	8477.870	48	176.622		
Total	245106.000	54			
Corrected Total	16435.704	53			

Based on the analysis of the two-way variants on the table, it is possible to draw the following sample:

a. H_{0A} is rejected or there is an influence of flipped classroom learning and inquiry learning on learning performance.
b. H_{0B} is rejected or there is an influence of learning style on learning performance.
c. H_{0AB} is rejected or there is an interaction between the learning model of inquiry learning and the flipped classroom with the student's learning style against learning achievement.

The results of the ANOVA two-way test in Table 5 showed that H0A was rejected which meant that there was an influence between the learning model and student learning achievement. Subsequently, a further post-ANOVA test with a significance of 0,05 was carried out with the aim of determining a learning model that was more effective in improving students' mathematical abilities. It will be outlined in the following table:

Table 6. Marginal Routine Learning Model

Learning Model	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Flipped Classroom	75.356	2.760	69.808	80.905

Learning Model	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Inquiry Learning	61.807	3.167	55.440	68.175

The ANOVA two-way cell test results showed that H0A was rejected, so it was necessary to perform a double comparison test of the learning model. The results can be seen in the table below:

Table 7. Comparison Test of Learning Models

(I) Learning Model	(J) Learning Model	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
Flipped Classroom	Inquiry Learning	13.549*	4.201	.002	5.103	21.995
Inquiry Learning	Flipped Classroom	-13.549*	4.201	.002	-21.995	-5.103

From the table above, the comparison of student learning performance subjected to flipped classroom and inquiry learning models obtained a significance level (Sig.) of 0.002 < 0.05, hence rejecting H_{0A}, indicating a difference in student learning performance receiving treatments of flipped classroom and inquiry learning models. The flipped classroom learning model has an average of 75.356 > 61.807, which is the average of the inquiry learning model. Therefore, the flipped classroom learning model is superior to the inquiry learning model.

Based on the table 7, it is found that the flipped classroom learning model is proven to be more effective compared to the inquiry learning model. Judging from the average mathematics learning achievement of students, the flipped classroom learning model has an average of 75,356, which is higher than the average learning achievement of students using the Inquiry learning model, which is 61,807.

Achievement in learning is influenced by the method of learning used, so to obtain maximum achievement, is required to apply an appropriate learning model. The choice of learning models or strategies has a considerable influence on improving learning outcomes (Ermawati et al., 2023). During flipped classroom learning, students are required to understand the material first before the learning process, so that students become more active when discussing in class (Hamidah & Kusuma, 2021).

Flipped classroom can be realized with a learning video that, in its implementation, can be repeated or played multiple times by students so that it can be adapted to their learning understanding (Aini, 2021). Thus, students are able to learn contextually, which is targeted in the 2013 or K13 curriculum. This model allows students to gain an understanding of basic concepts through the learning material presented before the class session. By providing an online learning resource in advance, students can arrange the learning time according to their individual needs and preferences This method can stimulate the independence of students, in particular in home learning, so that students can repeat the lessons given in the work and understanding of mathematics subjects, with more active involvement and flexibility, the flipped classroom model offers real benefits in enriching the experience and improving student learning performance (Widodo et al., 2021).

The inquiry learning model is also referred to as a learning approach that emphasizes the development of student thinking patterns, information-seeking skills, and making discoveries through question-and-answer processes or research. This model involves participants actively building knowledge and understanding through exploration, experimentation, and reflection. Inquiri learning is a series of learning activities that emphasize the process of critical thinking and analysis to find answers to a questionable problem (Rahmadhani et al., 2022).

Students are expected to be able to dig their own inquiry, because knowledge dug by the students themselves tends to be settled and embedded in the long-term memory (Utaminingtyas & Evitasari, 2021). However, many students who are less or less motivated have a strong urge to explore and find answers on their own, so the use of the inquiry learning model in mathematics learning is less effective.

The results of the ANOVA test on table 6 obtained a significance (Sig.) of the student's learning style of 0,008 which means that there was an interaction between the learning style and the mathematical learning achievement. After the interaction, an advanced post-ANOVA test was performed to evaluate the difference in the learning performance of students in each group. Overall, there are variations in learning achievement between groups of visual, auditory, and kinesthetic learning styles. The results can be seen in the following table:

Table 8. Double Learning Style Comparison Test

(I) Learning Style	(J) Learning Style	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Visual	auditor	16.29*	5.328	.010	3.40	29.17
	kinestetik	17.19*	5.647	.010	3.54	30.85
Auditor	visual	-16.29*	5.328	.010	-29.17	-3.40
	kinestetik	.91	4.015	.972	-8.80	10.62
Kinestetik	visual	-17.19*	5.647	.010	-30.85	-3.54
	auditor	-.91	4.015	.972	-10.62	8.80

Based on the table above, the results obtained are as follows:

a. The significance (Sig.) of visual and auditory learning styles is 0.010 < 0.05, indicating a difference between visual and auditory learning styles.
b. The significance (Sig.) of visual and kinesthetic learning styles is 0.010 < 0.05, indicating a difference between visual and kinesthetic learning styles.
c. The significance (Sig.) of auditory and kinesthetic learning styles is 0.972 > 0.05, meaning there is no difference between auditory and kinesthetic learning styles.

Based on the comparison test of learning styles, it is found that visual learning style has the highest average compared to both auditory and kinesthetic learning styles. This means that the visual learning style is better at improving student learning achievement.

Learning achievement is an evaluation of student learning outcomes expressed in the form of symbols, numbers, letters, or sentences indicating the achievements that each student has achieved in a given period of time (Lomu & Widodo, 2018). Then, learning style is a method that a person uses to assimilate and understand information quickly and efficiently according to their way of thinking (Alhafiz, 2022). Everyone has a different learning style, which can affect one's learning effectiveness. There are a variety of learning styles that are common, including visual, auditory, and kinesthetic.

Understanding students' learning styles allows teachers to adapt their teaching methods to suit students' needs, with the aim of improving student learning outcomes (Nabela et al., 2021). Differences in students' mathematical learning performance can be influenced by variations in their intelligence levels, such as logical-mathematical intelligence, verbal-linguistic intelligence, visual-spatial intelligence, and so on. Students with high levels of logical-mathematical intelligence will easily understand mathematical concepts. However, students with high verbal-linguistic intelligence can also help them

understand mathematics through oral or written explanation. In addition to intelligence, discretionary learning is involved in influencing learning outcomes (Tatminingsih, 2024). Therefore, students' achievements in mathematics can vary depending on the intelligence that each student possesses.

Putri et al. (2021), explain that learning styles influence educational processes, which relate to learning methods (curriculum), teaching methods, and evaluation as indicators of achievement of learning goals. Because they can see the materials taught in the form of images, students with visual learning skills will easily understand mathematical concepts.. The learning style of the student, with its characteristics, is a capital that influences the learning process and its communication (Falah & Fatimah, 2019).

Visual learning is also referred to as a more effective learning style to enhance student understanding. By using visual approaches, such as images, diagrams, or videos, students in processing of information delivered by teachers is made easier. Besides, visual use can also help to remember the learning given, thus strengthening the connection between the concepts of the lesson taught.

Students get a more attractive and visually verified learning environment when both are combined, which can help them connect abstract ideas with real-life examples. In addition, students will be asked to see, examine, and draw conclusions about the results of experiments or explorations they have done during the learning process with the inquiry learning model. As a result, students are more independent in solving problems, and their understanding of the material will be better.

CONCLUSION

Based on the results and discussion above, it can be concluded that: 1) There is a difference between the flipped classroom and inquiry learning models regarding students' mathematics learning achievement, with the average score of the Flipped Classroom model being 75.356, while the average score of the Inquiry Learning model is 61.807. This indicates that the Flipped Classroom model is proven to be more effective in improving students' learning achievement compared to the Inquiry Learning model. 2) There is a difference between learning styles and learning achievement; students with visual learning styles perform better than students with auditory or kinesthetic learning styles. 3) There is an interaction between the flipped classroom and inquiry learning models regarding students' learning achievement as viewed from their learning styles.

Based on this research, it is recommended that teachers choose the appropriate teaching model to be applied in the learning process, for example, the flipped classroom model, as the research results show that the flipped classroom model provides better learning achievement compared to the inquiry learning model. Teachers should also pay attention to students' learning styles because learning styles affect students' mathematics learning achievement, as demonstrated in this study that students with visual learning styles perform better than students with auditory or kinesthetic learning styles.

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