Mathematical Reasoning Ability In Linear Equations With Two Variables: The Impact Of Flipped Classroom

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Abstract: The flipped classroom is more competent in online assignments and activities and can control students learning outcomes. This study aims to see the flipped classroom effect on the improvement of students' mathematical reasoning abilities in the two-variable linear equation material. The method used in this research is quasi-experimental, and technical analysis using an independent sample t-test. The results showed that flipped classroom affects mathematical reasoning ability in the two-variable linear equation material. Based on the N-Gain criteria, the flipped classroom's average value is 72.41%, which is categorized as sufficient effective. The independent sample test calculation on the pre-test - post test data analysis with p-value = 0.000 $<\alpha = 0.005$ shows that there is an effect of students' mathematical reasoning abilities with flipped-classroom learning. The results showed that learning by flipped classroom was more effective than expository learning.

Keywords: Flipped classroom, linear equations, reasoning ability.

1. Introduction

Reasoning in the thinking process is needed in learning mathematics [1–3]. Activities in everyday life require the role of mathematics which is an important concern in education [4]. Problem solving, finding and communicating ideas that arise in the needs of students in learning mathematics [5]. Mathematics emphasizes the ability to practice thinking or reason, increasing creative activity, problem-solving skills [6,7], and communicating ideas [8].

Reasoning skills demand students when learning because mathematics and mathematical reasoning cannot be separated. The process of understanding, problem-solving, solving, and concluding that students have can make it easier for them to understand mathematics lessons. Students' skills can be built by improving mathematical reasoning [9]. Student character can affect mathematical reasoning skills. Mathematical reasoning in students is influenced by students' mathematical abilities so that students' low mathematical skills are still challenging to improve mathematical reasoning, so several indicators are needed to develop mathematical reasoning [10]. Mathematical materials will be readily understood through reasoning ability, and reasoning ability can be trained through math learning [11]. Mathematics should not be memorized in achieving high test scores, because mathematics is not easy to remember, so it requires interpretation and construction in learning mathematics [12]. Teachers who can calculate mathematical reasoning can help students improve mathematical reasoning so that students can develop their mathematical reasoning skills. Logical thinking, conceptual understanding, mathematical reasoning, and thinking skills can be solutions in solving mathematical problems [13].

One of the tests for mathematical reasoning ability was carried out by schools in three categories, i.e.: high, medium, and low [14]. The students' mathematical reasoning ability to solve problems in the high category is capable of fulfilling reasoning indicators well. Students who are in the category can meet the reasoning indicators quite well. Students with low-thinking abilities are less capable of performing reasoning indicators [15]. The highest level of mathematical reasoning ability students can solve the problem of statistical material [16].

Mathematical competencies can be developed by improving mathematical reasoning skills so that students are required to think critically and creatively. Students must also be confident in solving mathematical problems [17]. Students must evaluate the formulation of statements in mathematics in developing their reasoning abilities [18]. The ability to reason must be trained from an early age so that reasoning skills are easily taught through the learning process in the classroom using a learning model that can involve physical and mental activities [19]. Argument analysis, draw conclusions, analyze information, understand concepts, principles, rules, and obtain scientific findings. Secondary school students need to improve their mathematical reasoning skills [20].

The flipping class is a learning strategy focused on student engagement. Learners get the first explanation of material that is not in the classroom but at home using reading videos so that the classes used for students to work hard to review questions in the form of discussions, debates, and problems. Students watch their teaching videos at home to find individual lesson concepts according to learning prowess [21]. One of the benefits of a flipping class is that students can allocate time to prepare as much as they understand. A short-time student does not mean that there is no understanding at all over a long, diligent student. Teachers are responsible for guiding students to prepare for the right class so that inefficient or unproductive learning can be avoided [22]. Students appreciate the use of technology to allow an upside-down class approach. They have material before and after the learning process. The flipping class produces the desired results by providing pre-class video and related learning diagnostics that allow activities during a traditionally scheduled class. The perception of the benefits of pre-classroom learning videos and positive learning outcomes resulted in a positive influence on student satisfaction. Negative student opinions about flipping class models improve workload and preparation time. This statement is consistent with the research of Park and Howell [23].

Flipped classroom ratings are done with a view and performance. Anonymous surveys and face-to-face interviews make it possible to evaluate systems in perspective. The performative analysis was conducted by examining students' exam results from a traditional class two years earlier and flipped classroom last year. Overall, the results are positive. The students did not completely reject the new system. Recommendations for higher education institutions and practitioners when using reverse grade models to help students learn about sustainable development. First, it is considered essential to use an innovative approach in education. This study provides evidence that this perception has increased over the years as an active learning methodology. Pre-class flipped classroom activities can help reduce the cognitive burden and that the learning space maximizes student memory retention [24].

The flipped classroom has a significant effect on student learning experiences, engagement, generic skill development, and exam performance. First, students in the Reverse class group report a more positive learning experience than the control class. Secondly, students in the reversed class show better generic skills development. [25]. Increasing mathematical reasoning skills needs to be researched using the flipped classroom model, so this study aims to determine the increase in mathematical reasoning skills by applying the flipped classroom learning model to the material of two-variable linear equation systems.

Method

This study used quasi-experimental research with the total population in this study amounting to 319 class XI students of SMK Negeri 7 Bandar Lampung in the 2019/2020 academic year. The sampling technique used was random cluster sampling. From every 13 classes, two classes were taken as the experimental class (flipped classroom) and the control class (expository). The number of students in the class using the reverse class model was 32, and the class using the expository model was 33. The

research design used was a pretest-posttest control group design with a research instrument in the form of a pretest-posttest reasoning ability test. The prerequisite data analysis technique used the normality and homogeneity test. The N-Gain score was calculated from the pretest-posttest results, then analyzed of t-test using the SPSS 21.0 for Windows application to see the effect of improving students' mathematical reasoning.

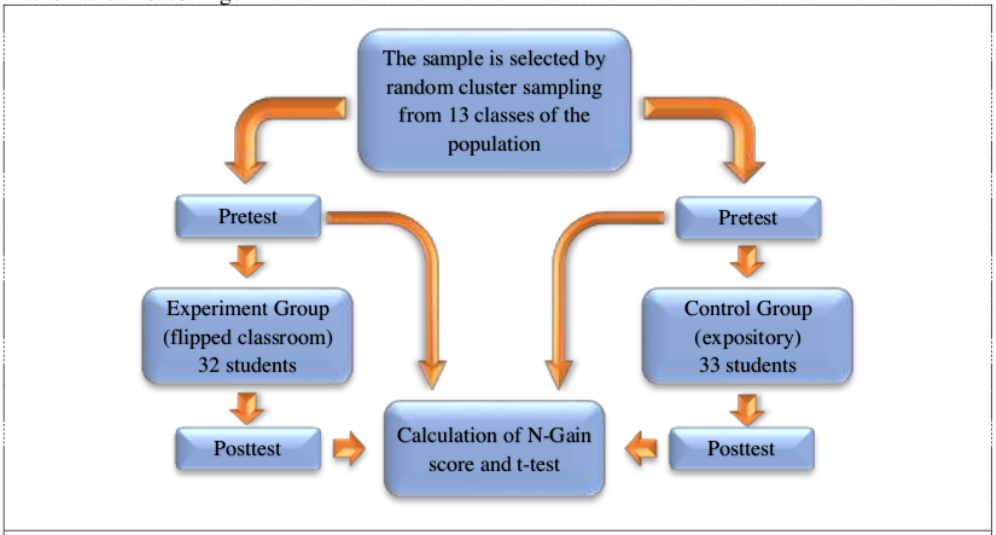

Figure 1. Flowchart of the research

3. Results and Discussion

Table 1 shows the descriptive analysis in determining the range, highest value, lowest value, average.

Table 1. Descriptives Data of Pretest-Posttest Results

Treatment	N	Range	Min	Max	Mean
Flipped classroom	32	100.00	0.00	100.00	72.4141
Expository	33	76.92	0.00	76.92	31.3039

Table 1 shows the average value in the flipped classroom model of 72.4141, while the expository model is 31.3039. The highest average value is found in the flipped classroom model, with an average value of 72,4141. The normality test is shown in Table 2, and the homogeneity test is shown in Table 5

Table 2. Normality N-Gain Kolmogorov-Smirnov[a]

Class	Statistic	df	Sig.
Flipped classroom	0.145	32	0.083
Expository	0.113	33	.200*

Table 2 shows that the p-value of the Kolmogorov-Smirnov test in the flipped classroom is 0.083, and the class with the Expository model is 0.200, so this indicates that the p-value of all treatments is higher than the value of $\alpha = 0.005$. From the data that the Kolmogorov-Smirnov test has performed, the data is normally distributed. Table 5 shows Levene's test results to confirm the p-value> significant level so that homogeneous data can be accepted.

After learning that data is usually distributed homogeneous, then the N-gain score and analysis of test independent samples t-test. The following table displays criteria N-gain percent.

Table 3. N-Gain Effectiveness Category [26]

Percentage (%)	Category (C)
$C < 40$	Ineffective
$40 \leq C < 55$	Less Effective
$55 \leq C < 75$	Quite Effective
$C \geq 75$	Effective

Table 4. Percentage N-Gain Score

	Max	Min	Mean
Flipped classroom	100.00	0.00	72.4141
Expository	76.92	0.00	31.3039

The table above shows the average value of the flipped classroom is 72.41%, included in the category of quite effective/quite useful with an N-Gain Min 0.00%, and Max 100.00%. The average cost of the expository class is 31.30% included in the ineffective/ineffective category with an N-Gain Min 0.00%, and Max 76.92% based on the n-gain effectiveness category criteria according to table 3.

Table 5. Independent Samples t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	t	Df	Sig.(2-tailed)	Mean Difference
N-Gain Percent	Equal variances assumed	2.265	0.137	7.323	63	0	41.1102
	Equal variances not assumed			7.286	55.963	0	41.1102

Mathematical reasoning ability can be seen that the p-value ≤ significant level α = 0.05, so the treatment using the flipped classroom model has a significant effect. The conclusion is that there is an influence on students' mathematical reasoning ability with the flipped classroom. The results of this study indicate that the calculation of the independent sample test in the pretest-posttest data analysis with p-value = 0.000 <α = 0.005 so that there is an effect of students 'mathematical reasoning abilities with the flipped classroom learning model, and the average students' mathematical reasoning abilities.

Research on the Flipped classroom model in improving problem skills, creative thinking, critical thinking, and conceptual understanding has been done. Still, it also needs to be researched regarding mathematical reasoning abilities [27–30]. There are differences in the influence of flipped classroom learning towards the mathematical reasoning ability of learners. From the research conducted in SMKN7 Bandar Lampung in the experimental class that is XI Akuntansi 1 applied to the flipped classroom learning model, learners are led to learn at home using the learning videos that the author has given before the day of study. When teaching, students are divided into five heterogeneous groups. Quiz material system of two-variable linear equations is given to students and discussed with friends as a group, then the appropriate determined method to answer the quiz. Assistance in answering quizzes is given to students if they still cannot solve the given problem. The answers obtained from the discussion group were presented by one of the members in the discussion group, then asked for a response from the other discussion group.

The students of the control class are given a learning model that the teacher has applied to the expository model of study, and the teacher began with theories submitted to the students. Learners pay attention to the problems presented by the author, and the authors guide learners to determine what major problems can be dug from the value of the variables on the SPLDV in contextual matters. The teacher guides learners to gather all information obtained through books or discussions regarding the completion of variable values in the SPLDV. Next, the author presents the problem and asks the learners to solve problems in SPLDV learning. Expository learning has not been able to improve students' mathematical reasoning. Students still have difficulty solving problems in the two-variable linear equation system material, so the results of mathematical reasoning obtained by students in expository learning are not in line with expectations.

The results that the authors gained have relevance to the previous research results that flipped classroom learning can help learners with learning difficulties. Students can understand materials with freely uploaded teaching materials, where learners can see the learning videos repeatedly until the learners can understand the learning materials they find difficult [31].

The results of research conducted by the authors also have relevance to the study stating that the average mathematical reasoning of learners after using the flipped classroom learning model is better than before using the flipped classroom learning model. The result of N-Gain using the flipped classroom learning model has high effectiveness in mathematical reasoning ability [32]. Short videos are watched by students at home, while classroom time is devoted to rehearsals, projects, or discussions. A flipped classroom approach as an educational technique consisting of two parts: an interactive group learning activity next to the class and directing computer-based individual instruction outside the classroom. The classroom flipped approach consists of several forms of pre-class activity before class meetings and completing individual or group activities during face-to-face lessons. Class attendance is mandatory, as the instruction in the classroom is crucial for the learning process [33]. The classroom flipped approach is the opposite of the traditional class approach. Traditional classroom approaches use lecture methods, as teachers explain concepts and share some exercises students have to complete at home. Classroom approach flipped classroom to implement home learning, and when learning at school is used for interactive activities such as exercises and discussions. Students feel satisfied with flipped classroom learning [34]. Flipped classroom's approach to education resulted in a positive impact on students' achievements, while the traditional classes were still unable to make students satisfied in the course of learning [35].

The flipped classroom is a mixture of traditional and online learning by utilizing time inside and outside of the classroom to be more effective. The main character of a flipped classroom teaching method is a student who has more responsibilities in the learning process than the teacher. Students have a positive perception of flipped classroom models in different educational situations. In particular, a study in two different classes showed that students loved the flipped classroom model. Teaching instruments used in flipped classroom models are needed in the learning process [36].

4. Conclusion

The learning process of a flipped classroom with two-variable linear equation system material produces effective mathematical reasoning skills. The increase in mathematical reasoning abilities in the flipped classroom model has a significant effect compared to the learning model commonly used by teachers in these schools. The flipped classroom is the teacher's choice as a learning model in improving mathematical reasoning in the two-variable linear equation system material. Suggestions for further researchers need to research with different materials, and more exciting learning videos are required. Implications for teachers can use flipped classrooms as alternative learning in improving mathematical reasoning.

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