

THE EFFECT OF THE FLIPPED CLASSROOM MODEL ON THE MATHEMATICAL CRITICAL THINKING ABILITY OF ELEMENTARY SCHOOL STUDENTS

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Abstract

This research study aims to determine the effect of the flipped classroom model on students' mathematical critical thinking skills. The research sample involved 35 grade 5 students of a public elementary school in Waai, Salahutu District, Central Maluku Regency. The research method uses a quasi-experimental and is analyzed using a paired sample test. The results of the analysis show that there is a positive influence from the flipped classroom learning model on students' mathematical critical thinking skills in the concept of fractions. To find out the increase in critical thinking skills, N-gain is used. The findings showed that there was an increase, wherein the high category achieved an increase of 3.33%, the medium category was 93.34%, and the low category was 3.33%. The increase is because the flipped classroom model can create a dynamic and interactive mathematics learning environment with the help of learning videos, so students can think critically in exploring creative ideas to solve math problems.

Keywords: flipped classroom model, mathematical critical thinking, interactive learning



1. Introduction

Advances in technology have an impact on various aspects of human life, especially education in the world, including Indonesia. The impact of technology is implemented with the presence of modern learning in schools.

Modern learning triggers the use of creative learning applications and models so that students are facilitated with various programs that can help them master mathematics subject matter in class. Learning video-assisted mathematics is important to implement, because it can assist teachers in achieving the effectiveness of presentation of subject matter, triggers students to better understand the material being studied, and provides opportunities for students to ask questions regarding the material contained in the learning video.

The results of the identification show that learning mathematics in fifth grade at the research location has not optimized the use of learning videos, which of course has an impact on students' ability to analyze challenging mathematical questions or problems. Students in the fifth grade level are a transitional stage from basic education to junior secondary education, so that the strengthening of critical thinking skills needs to be increased, through video-assisted learning.

The combination of video and text is the most effective teaching process Ghilay (2021). The combination of animation and presentation audio (essentially moving images and sound) provides a more effective learning experience than still images accompanied by text, or traditional approaches (Mayer, 2001; Ghilay, 2021).

One of the technology-integrated learning models in the classroom is the flipped classroom. Piehler (2014) the flipped classroom model is a pedagogical approach and is reverse learning where direct instruction moves from group study rooms to individual study rooms, and the resulting group rooms are transformed into a dynamic and interactive learning environment where teachers guide students as they apply concepts and engage creatively in discuss the subject matter.

The classroom's flipped model design is a new phase in education, but not an entirely new idea. Teachers often assign students to study at home and then expect students to present their work in class (Strayer, 2012). Flipped Classroom implementation allows students to watch video recordings of learning outside the classroom so that learning time is more effective and triggers

students to be active when practicing in class (Strayer, 2012; Unakorn & Klongkratoke, 2015).

The flipped classroom model is potential and extraordinary learning because it involves students in applying knowledge, thus triggering them to think at a higher level (Davies et al, 2013; Flumerfelt & Green, 2013; Nguyen, 2017). Flipped classroom creates an active learning environment because learning is student-centered and the teacher is only a facilitator (Charles-Ogan & Cheta, 2015; Shi et al., 2020; Staddon, 2022).

Flipped classroom is a form of creative learning that can trigger an increase in learning outcomes and mathematical critical thinking skills, because students are faced with problems related to real life that are implemented in learning videos. Him Fung et al., (2021) students are trained by presenting contextual problems through learning videos. The flipped classroom is a learning technique that consists of two parts, namely: interactive group learning activities in the classroom, and individuals can directly study outside the computer-based classroom

Unakorn dan Klongkratoke (2015) flipped classrooms can provide opportunities for students to be actively involved and help them achieve their learning goals. Teaching mathematics using flipped classrooms in measuring critical thinking skills is better than traditional learning (Al-Zoubi & Suleiman, 2021). There are differences in critical thinking skills, mathematics achievement, and psychological stress in the experimental and control classes before and after implementing the flipped classroom (Atwe et al., 2022).

Mathematical critical thinking skills and students' conceptual understanding of fractional material can be improved by presenting contextual-based creative learning related to students' real lives with the help of learning videos. The use of creative videos in learning fractions can improve their critical thinking skills and understanding of concepts. Students who have critical thinking skills can solve challenging math problems. Rapi et al., (2022) critical thinking skills and good conceptual understanding will help students solve contextual problems.

The concept of fractions presented in the learning video contains contextual problems, thus triggering students to construct creative ideas. Creative mathematical ideas from each student will be integrated during the process of solving math problems in class. Rapi et al., (2022) flipped classroom-based assessment is one of the innovative constructivism assessments that can

improve conceptual understanding and critical thinking.

The flipped classroom model also provides opportunities for students to actively collaborate in solving fractional problems, so that it is expected to have an impact on improving students' critical thinking skills, Unakorn and Klongkratoke (2015) flipped classroom can provide opportunities for students to be actively involved and help them achieve their learning goals.

2. Method

The approach in this study is a quantitative approach with a quasi-experimental research type. The research sample involved 35 grade 5 students at an elementary school in Negeri Waai, Salahutu District, Central Maluku Regency

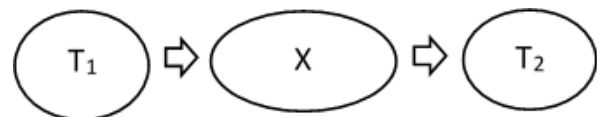


Figure 1. One Group Pretest Posttest Design Information:

- T₁ : pretest given before treatment
- X : Treatment with flipped classroom model
- T₂ : posttest after being given treatment

The research data were in the form of a critical thinking ability test and were analyzed using the dependent sample t-test with the Paired Sample test type,

The stages of implementing learning in analyzing the effect of the flipped clasrum model are shown in Figure 2.

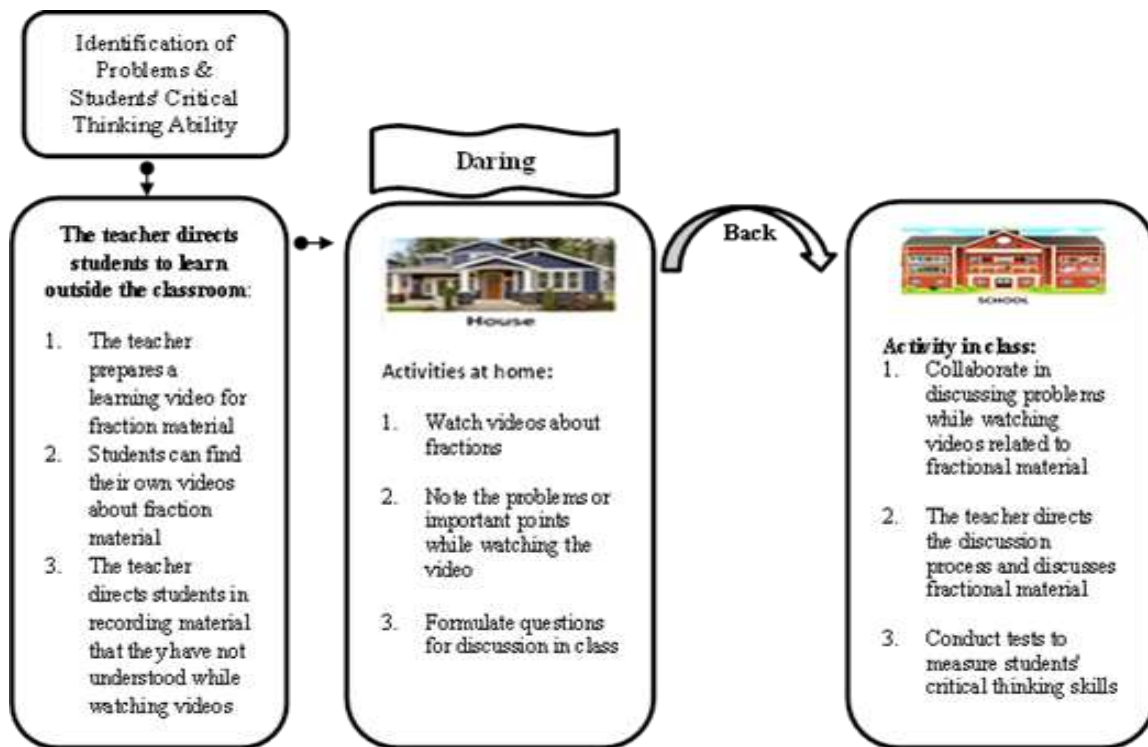


Figure 2. Design of the Flipped Classroom Model

Prior to testing, a prerequisite test for normality and homogeneity of the data was carried out. In analyzing the increase in students' mathematical critical thinking skills, the Normalized-gain formula is used (Meltzer, 2002; Takaria & Talakua, 2018).

$$Ngain = \frac{Posttest\ Score - Pretest\ Score}{Maximum\ Possible\ Score - Pretest\ Score}$$

The resulting gain value is then confirmed with predetermined criteria in seeing the increase in students' critical thinking skills. Table 1 presents the N-gain criteria (Hake, 1998).

Table 1. Criteria for N-gain Value

N-gain (<g>)	Classification
$g \geq 0,70$	Hight
$0,30 \leq g < 0,70$	Currently
$g < 0,30$	Low

3. Results and Discussion

3.1 Results

The results of the study consisted of descriptive statistical analysis in the form of presenting parameters and inferential testing to see differences in critical thinking skills before and

after the flipped learning model was applied, and the improvements were analyzed.

a. Critical Thinking Ability Difference Test

Before conducting the Paired Samples Test to see the effect of the flipped classroom model on critical thinking skills, the first step is to test the prerequisites for normality and homogeneity of the data. The test criteria set are, if the Sig value > 0.05 then the data is normally distributed and homogeneous. Table 3 displays the results of the normality test and homogeneity of the critical thinking ability test data.

Table 2. Normality and Homogeneity Test

Normality test (Kolmogorov-Smirnov Test)			
	Significant Value	α	Decision
Pretest	0,152	0,05	Normal
Posttest	0,077	0,05	Normal
Homogeneity Test (Levene Test)			
Pre-Post Test	0,274	0,05	Homogeneous

Table 2 shows that the normality test obtained a value of Sig > 0.05 for both pretest and posttest data. These results indicate that the data is normally distributed. Then a homogeneity test was carried out with the Levene test type. The test results obtained a Sig value of $0.274 > 0.05$, meaning that the data is homogeneous. Based on these two test conditions, a difference test can be carried out using the Paired samples test

Before the Paired Samples Test was carried out, the research hypothesis was first determined as follows:

H_0 : There is no difference in students' critical thinking skills before and after the flipped classroom model is applied

H_1 : There are differences in students' critical thinking skills before and after the flipped classroom model is applied

To analyze whether there are differences in students' critical thinking skills before and after the flipped classroom model is applied, the Paired Samples Test is used. Table 4 presents the test results.

Table 4. Test of Differences in Critical Thinking Ability

Pair	Statistical Parameters		Significant Value
	Mean	Std. Deviation	
Pre_Test - Post_Test	26,166	5,97	0,000

After testing using the Paired samples test, a Sig value of 0.000 was obtained and this result was less than 0.05, so a decision was made to reject H_0 and H_1 to be accepted, which meant that there were

differences in students' critical thinking abilities before and after the flipped classroom was applied. These results indicate that there is an effect of the flipped classroom model on students' thinking abilities.

b. Description of Critical Thinking Ability

To provide an overview of the statistical parameters of students' critical thinking skills before and after the flipped classroom model is applied, Table 3 presents a description of the statistical parameters.

Table 3. Description of Critical Thinking Ability

	Statistical Parameters			
	Max Value	Min value	Mean	Std. Devices
Pretest	35	65	47,33	11,19
Posttes	50	90	73,50	9,57

Table 3 shows that the standard deviation of the pretest is 11.19 and the posttest is 9.57. These results indicate that the diversity of students' critical thinking abilities after the flipped classroom model is applied is smaller, meaning that students' critical thinking abilities after the flipped classroom model is relatively not significantly different. This achievement shows that the flipped classroom model has an effect on students' critical thinking skills.

c. Analysis of Increasing Students' Critical Thinking Ability

To measure the increase in students' critical thinking skills after the flipped classroom model was applied, it was analyzed using normalized gain. Figure 3 presents the results of the N-gain test, frequency, and percentage increase.

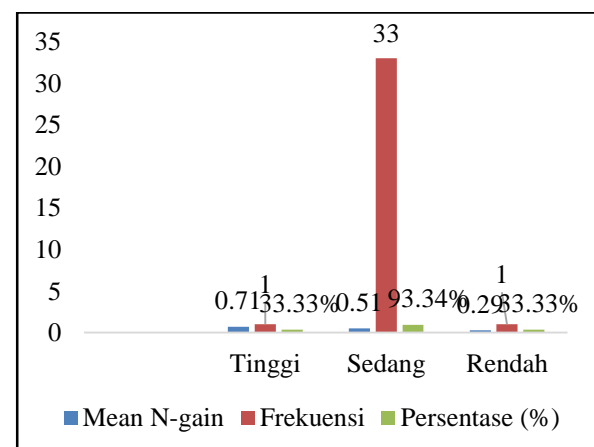


Figure 3. Improved Critical Thinking Ability

Figure 3 shows that there is an increase in students' mathematical critical thinking skills in the concept of fractions. The increase in the high category was 3.33% with an average N-gain of 0.71. For the medium category, it is 93.34% with an average N-gain of 0.51 and for the low category,

it is 3.33% with an average gain value of 0.29. These results indicate that the flipped classroom model is effective in improving students' mathematical critical thinking skills.

3.2 Discussion

Critical thinking skills are important for elementary school students to have in learning mathematics, especially in the concept of fractions. The ability to think critically that triggers students to explore creative ideas in solving problems. Birgili (2015) creative thinking is correlated with critical thinking, and problems solving

To improve students' critical thinking skills, it is necessary to apply creative learning models, one of which is the flipped classroom model. The flipped classroom model is video-assisted learning and has the potential to trigger students to think critically.

Flipped classroom creates an active learning environment because learning is student-centered and the teacher positions himself as a facilitator. Ramadhani et al., (2020) flipped-Classroom is a type of Blended learning model that combines online learning and face-to-face learning. This combination of learning emphasizes contextual problem-based learning which is effective in improving students' mathematical abilities.

Based on the results of the study, it was found that there was an effect of the flipped classroom model on students' critical thinking skills in the concept of fractions. It was also identified that there was an increase in critical thinking skills in the high, medium, and low categories. The increase is due to the flipped classroom model turning student learning activities, which are usually carried out in groups in the classroom, into activities outside the classroom with the help of learning videos.

The implementation of the flipped classroom model is carried out by providing videos by the teacher regarding fraction material to be studied individually at home. Furthermore, collaboratively in class students explore the material more deeply. The learning environment is built through dynamic and interactive group discussions so that students can explore creative ideas.

The flipped classroom model is integrated via video, thus helping teachers in delivering subject matter. Another aspect is that teachers can use more opportunities to explore students' creative ideas. (Chang et al., 2020) flipped classroom involves students applying their knowledge, and interacting with educators and peers to share

knowledge and ideas, so as to improve higher-order thinking and communication skills.

The use of learning videos containing fractional material provided by the teacher and other videos prepared by students as a source of learning mathematics, is effective in increasing students' conceptual understanding and critical thinking skills. Prihatin (2019) the flipped classroom model is effective because: (1) it is in accordance with the learning styles of today's students, where students are very close to technology; (2) helping students have positive activities outside of school; (3) helping students who want to try to understand the learning material; (4) increasing interaction between students and teachers; and (5) changing class management.

Students also gave positive responses to the implementation of the flipped classroom model. The results of the interviews showed that students were interested in using learning videos, because through videos they could understand fractional material well. The videos given by the teacher are also contextually based so that what is learned is more meaningful and can improve students' understanding and critical thinking skills. Saputra & Mujib (2018) use mathematics learning videos can improve students' understanding of mathematical concepts. Strohmeyer (2016) flipped learning can make students learn more deeply because students are actively involved and interact, thus triggering an increase in critical thinking skills.

4. Conclusion

The flipped learning model influences students' critical thinking skills. Students' mathematical critical thinking skills have increased in the high category of 3.33% and the medium category of 93.34%, and the low category of 3.33%. This increase is due to the effectiveness of the flipped learning model. The flipped classroom model assisted by learning videos can facilitate learning mathematics, especially the concept of fractions, where students learn as a structure in solving mathematical problems by exchanging ideas through videos that are broadcast and the teacher acts as a facilitator.

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