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Implementation of the Flipped Classroom Learning Model Assisted by Educational Videos on Elasticity in Training Critical Thinking Skills of High School Students

T. Susi Juliani*, Zuhdi Ma,ruf, Muhammad Sahal

Faculty of Teacher Training and Education, Universitas Riau, Pekanbaru, 28293, Indonesia

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* Corresponding author.

E-mail: t.susi0676@student.unri.ac.id

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ABSTRACT

For educational purposes, a suitable learning model is needed to support student learning activities, which in this case will be used as a learning model in the form of a flipped classroom assisted by digital-based learning videos. The purpose of this study is to describe students' critical thinking skills after using the Flipped Classroom learning model with the assistance of learning videos on the subject of elasticity. This study uses a quasi-experimental design with a posttest-only design. Based on the post-test results related to students' critical thinking skills in the experimental class, the average score was 82.40 with a standard deviation of 15.9, indicating a very critical category when viewed from the category of critical thinking skill score scale. Meanwhile, the post-test results conducted in the control class yielded an average score of 62.34 with a standard deviation of 14.2, indicating a less critical category. Thus, it can be concluded that the implementation of the flipped classroom learning model with the assistance of educational videos on the topic of elasticity was successful in developing critical thinking skills in students.

1. Introduction

The implementation of home-based learning policies in educational institutions has clearly caused major disruptions to the learning process. Ultimately, the government mandated nationwide online learning, which has been in place for months. Online learning, offline learning, and even blended learning have been implemented by educators to improve the quality of

learning during this pandemic (Rosidah, [2021](#)). According to 21st-century education, to support the implementation of e-learning in schools, several things must be considered, namely the quality of human resources, self-development, and technology and innovation (Mardhiyah, [2021](#)). In this context, teachers' ability to utilize technology in classroom learning is crucial to improving the quality of education. However, in practice, distance learning

using e-learning has primarily involved assigning tasks without providing explanations of the material to students. This has led to high levels of student boredom with the learning process, which may result in a decline in critical thinking skills (Aji, 2020). According to Sagita (2022), several factors contributing to low student learning outcomes in physics include the implementation of learning processes that do not sufficiently engage students. In fact, students' critical thinking skills are relatively low. This is based on the four-yearly International Trends in International Mathematics and Science Study (TIMSS) conducted on students using high-cognitive-level questions that can measure critical thinking skills, showing that Indonesian students consistently rank at the bottom.

Therefore, there is a need to improve the quality of learning to make it more meaningful and address students' low motivation in learning, which leads to the need for new innovations in the teaching and learning process to enhance students' critical thinking skills. An alternative solution to this problem is to seek learning models or media that align with students' needs and challenges during the learning process. One new learning model that addresses the above student issues is the flipped classroom, designed through the integration of technology for a more personalized, interactive, and flexible learning environment. The main feature of the flipped learning classroom is the use of methods and content that facilitate independent and flexible learning, as well as student performance in active face-to-face meetings outside the classroom. The purpose of this study is to describe the process of implementing the flipped classroom learning model assisted by learning videos to improve students' critical thinking skills in the subject of elasticity. In addition, this study also aims to determine the improvement in students' critical thinking skills with the implementation of the flipped classroom learning model assisted by learning videos in the subject of elasticity.

2. Methodology

The type of research used in this study was quasi-experimental with a posttest-only design, namely one experimental class and one control class (Cresswell, 2012). The class design used can be seen in Table 1.

Table 1. Research Design

Class	Treatment	Final Exam
Experiment	X	O ₁
Control	-	O ₂

This study will be conducted at State Senior High School 2 Pangkalan Kerinci. In this study, the author only used two classes with a total of 54 students as research samples, each of which will be grouped into a control class and an experimental class. The samples in this study were selected based on normality and homogeneity tests of previous test scores, which were prerequisites before the study was conducted. After conducting normality and homogeneity tests, the determination of the experimental class and control class was carried out using simple random sampling techniques through random selection. The data collection method used in this study was a test of students' critical thinking skills. The data analysis techniques used in this study were descriptive analysis and inferential analysis.

The descriptive analysis conducted in this study aimed to provide an overview of critical thinking skills. The analysis of the results of the students' critical thinking skills test was based on the categories of critical thinking skills shown in Table 2.

Table 2. Categories of score scales

Levels	Description
$81,00 < x \leq 100$	Very Critical
$61,00 < x \leq 80,59$	Critical
$41,00 < x \leq 60,59$	Moderately Critical
$21,00 < x \leq 40,59$	Less Critical
$0,00 < x \leq 20,59$	Not Critical

(Cresswell, 2012)

Inferential analysis was conducted to determine the differences between each group by performing normality tests, homogeneity tests, and hypothesis tests. Normality tests were conducted to determine whether the data collected came from a normally distributed population. The normality tests were conducted using the Kolmogorov-Smirnov test, while the hypothesis tests were conducted using the independent t-test. The hypothesis test in this study was to see the improvement in students' critical thinking skills between classes that applied the flipped classroom learning model assisted by learning videos and classes that applied conventional methods.

3. Results and Discussion

In this study, the data analyzed was students' critical thinking skills data from the experimental class and control class on the subject of elasticity. Students' critical thinking skills data was obtained from the results of a post-test administered after treatment using a flipped classroom learning model assisted by instructional videos with the Problem Based Learning

method in the experimental class and conventional learning in the control class. Figure 1 is a screenshot from one of the videos that was used as a problem in the experimental class.



Figure 1. One of the Video Clips of the Problem Given in the Experimental Class

The description of critical thinking skills can be seen based on the aspects of critical thinking skills, namely: formulating problems, providing arguments, performing deduction, performing induction, performing evaluation, and deciding and implementing. The post-test data on students' critical thinking skills in the experimental class and control class per aspect are shown in Table 3.

Table 3 Analysis of Critical Thinking Skills of Students in the Experimental Class and Control Class per Aspect

No	Critical Thinking Skills Indicators	Class			
		Experiment		Control	
		Number of Students	Student Success Rate	Number of Students	Student Success Rate
1	Formulating Problems	27	86,11	27	72,22
2	Providing Arguments	27	93,59	27	77,77
3	Performing Deduction	27	88,88	27	74,07
4	Performing Induction	27	88,88	27	79,62
5	Performing Evaluation	27	68,51	27	42,59
6	Deciding and Implementing	27	69,44	27	27,77

Table 3 shows the average critical thinking skill scores for the experimental class, which were compiled according to critical thinking skill aspects. The average post-test scores for the experimental class for each indicator tended to be higher than the average post-test scores for the control class. Thus, it can be seen that there are differences in each aspect of critical thinking skills in the post-test scores of the experimental class, which was treated with the implementation of a flipped classroom learning model assisted by learning videos using the problem-based learning method, and the control class, which was treated with conventional learning processes on the topic of elasticity for high school students. Table 4 shows the average critical thinking skills of both classes.

Table 4 Results of critical thinking skills of students in the experimental class and control class

Class name	Number of Students	Post-test		
		Average score (M)	Standard Deviation (SD)	Skills
Experiment	27	82,40	15,9	Very critical
Control	27	62,34	14,2	Less critical

Table 4 shows that the post-test results related to students' critical thinking skills in the experimental class indicate a very critical category, as reviewed from the critical thinking skills score scale categories in Table 4. Meanwhile, the post-test results conducted in the control class indicate a less critical category.

In processing the data with inferential analysis, the researcher used the IBM SPSS version 26 data processing application. The inferential analyses observed by the researcher were normality tests, homogeneity tests, and hypothesis tests. Before conducting the hypothesis test to determine whether the preliminary hypothesis could be accepted or rejected, the researcher first ensured that the data to be processed met the requirements, namely that the data must be normally distributed and homogeneous through the post-test results of critical thinking skills in the experimental class and the control class.

The normality test used by the researcher in this study was the Kolmogorov-Smirnov test, which can be seen in its entirety in the appendix. It can be explained that the significance result in the experimental class is 0.200, which means that the value obtained in the experimental class is ≥ 0.05 , and the significance result in the control class is 0.200, which means that the

value obtained in the control class is ≥ 0.05 . Therefore, it can be concluded that the data obtained is normally distributed based on the Kolmogorov-Smirnov normality test. The homogeneity test used a one-way ANOVA, which can be seen in its entirety in Appendix 9, namely the test of homogeneity of variances. It can be explained that both classes have homogeneous variances with a significance value of 0.211, meaning that the value is greater than or equal to 0.05 ($0.211 \geq 0.05$). After both requirements were met, in other words, the data obtained was normally distributed and also homogeneous, the researcher could then conduct the previously established hypothesis test.

The hypothesis test used by the researcher in this study was the independent-sample t-test. The hypothesis test was conducted to determine whether there was an increase in students' critical thinking skills in the experimental class and the control class in the elasticity material. The t-test conducted in this study aims to test the null hypothesis (H_0). Based on the output of the independent-sample t-test conducted using SPSS software version 26, the significance level

(two-tailed) was 0.000. For an independent t-test, if the significance level obtained is < 0.05 , then H_0 is rejected and H_1 is accepted. Based on the significance value obtained through the test, $0.000 < 0.05$, H_0 is rejected and H_a is accepted, so it can be concluded that there is a significant difference in the average scores of students' critical thinking skills between the experimental class that applies the flipped classroom learning model assisted by learning videos and the class that applies the conventional learning model in the elasticity material. In other words, it can be said that the average critical thinking skills of students who applied the flipped classroom learning model assisted by instructional videos were higher than those of the class that applied the conventional learning model.

The critical thinking skills tested in students consisted of 5 aspects with 6 indicators selected. The critical thinking skills scores for the experimental class and the control class based on the post-test results compiled per aspect can be seen in Figure 2.

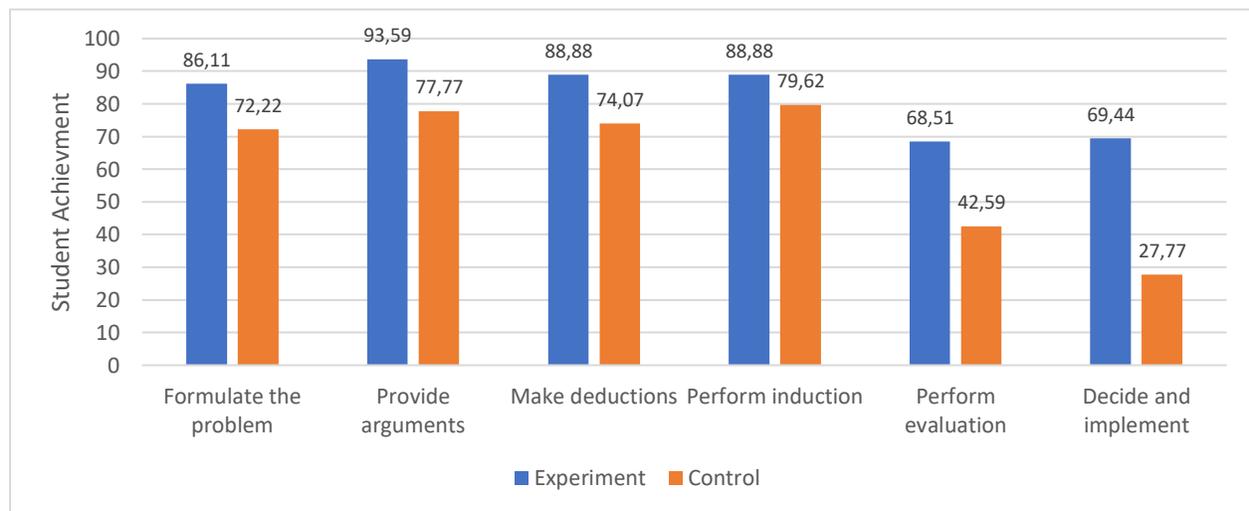


Figure 2 Results of the Post-Test on Critical Thinking Skills in the Experimental Class and Control Class

Based on the figure above, it can be seen that the average post-test score for critical thinking skills in the experimental class is higher than the average post-test score for critical thinking skills in the control class. The post-test scores for critical thinking skills in both the experimental class and the control class show significant differences when examined by each indicator aspect. The highest average post-test score interval for the experimental class is on the “providing arguments” indicator, while the highest post-test score for the control class is on the “conducting induction” indicator. The lowest average post-test score interval for the experimental class was in the indicator of

conducting evaluations, while the lowest post-test score for the control class was in the indicator of deciding and implementing.

The following is a further description of students' critical thinking skills as seen from each aspect of the indicator.

Formulating Problems

Based on critical thinking skills, the indicator of formulating problems is included in the aspect of providing simple explanations (Elementary

Clarification), which is the process of focusing questions through identifying or formulating questions (a problem), asking and answering questions by gathering facts or reasons related to a problem presented. In the post-test question (Figure 3), the critical thinking skill assessed includes one question

related to the aspect of providing a simple explanation with the problem formulation indicator, where students are asked a question related to the phenomenon of shock absorbers in a motor vehicle.

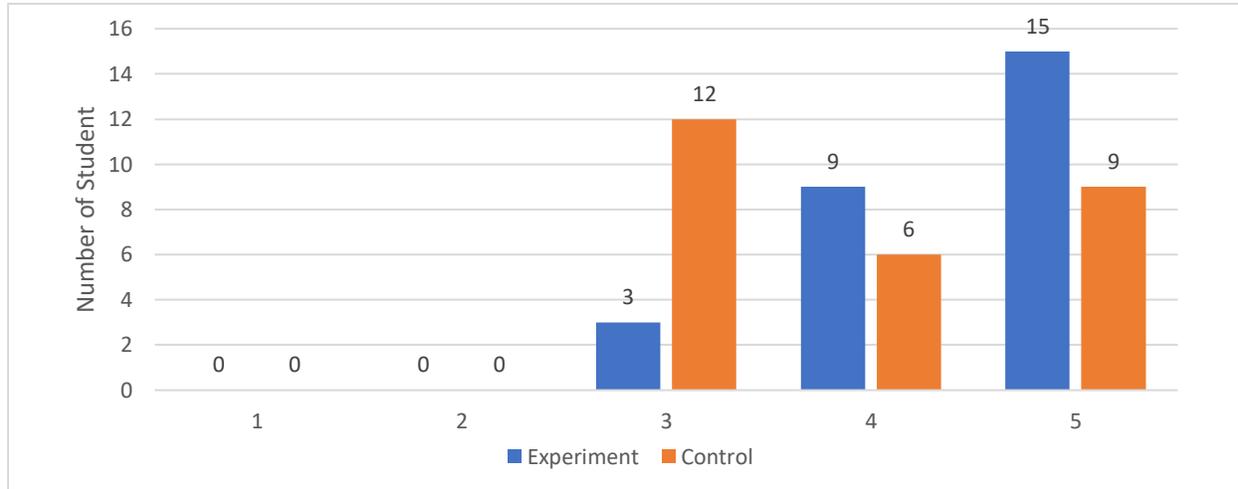


Figure 3 Comparison of Problem Formulation Indicators

Based on the diagram above, it can be seen that there is a difference in post-test scores for problem formulation questions between the experimental class and the control class. According to the data on the average percentage of student scores for problem-formulation questions, the success rate of students in the experimental class was 86%, while the success rate of students in the control class was 72%. This was achieved through problem-based learning strategies with the help of videos during the orientation phase for students regarding the problem. According to Famella (2014), the application of the problem-based learning strategy can be carried out through student investigation activities in formulating the causes of a presented problem and deciding how the presented problem could occur.

In this indicator, the problem addressed is the application of the theory of elasticity to the differences in the number of shock absorbers used in each vehicle. Based on the results obtained, it was stated that this process can train students' critical thinking skills through the problems presented. This is in line with Syahrani Ejin's opinion in Anugraheni (2018), who

stated that problem-based learning strategies that present real-life (contextual) problems from the environment can improve students' critical thinking skills.

Providing Arguments

In line with the critical thinking skill aspect, the indicator of providing arguments is included in the aspect of building basic skills (Figure 4). In this aspect, students will think systematically to obtain a source for considering and observing a problem. In this aspect, students are focused on being able to know and consider the truth of a theory obtained from a particular source. In this study, students were given a data source on Hooke's law, and then they analyzed the truth of the concepts and facts contained in the question.

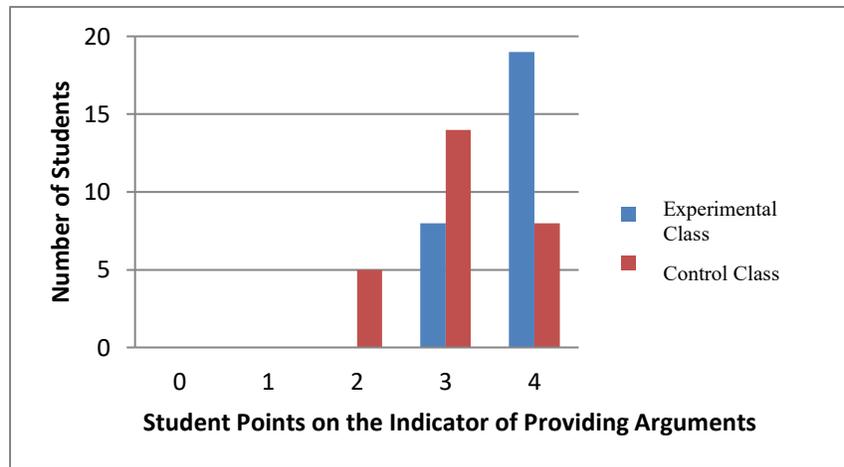


Figure 4 Comparison of Indicators for Providing Arguments

Based on the diagram above, it can be seen that there is a difference in the post-test scores for the argumentation questions between the experimental class and the control class. According to the data, the average percentage of student scores for the argumentation questions in the experimental class was 92%, while the success rate of students in completing the argumentation questions in the control class was 78%.

During the learning process, this skill is developed through activities such as watching videos and conducting observations in class with the assistance of the KIT tool and LKPD, which can help students become proficient in providing arguments and opinions in accordance with the problems presented. This is in line with the opinion expressed by Winarti (2018) that problem-based learning media with the

Problem-Based Learning strategy is effective in training critical thinking skills if it can lead students to find ideas and express as many alternatives as possible in accordance with the problems presented.

Performing Deduction

Based on critical thinking skills, performing deduction is included in the aspect of making inferences (Figure 5). This aspect focuses on deducing and considering a deduction by interpreting questions. In this study, students were given questions in the form of a series and parallel spring arrangement. Then, students deduced the replacement constant that could be used in the circuit.

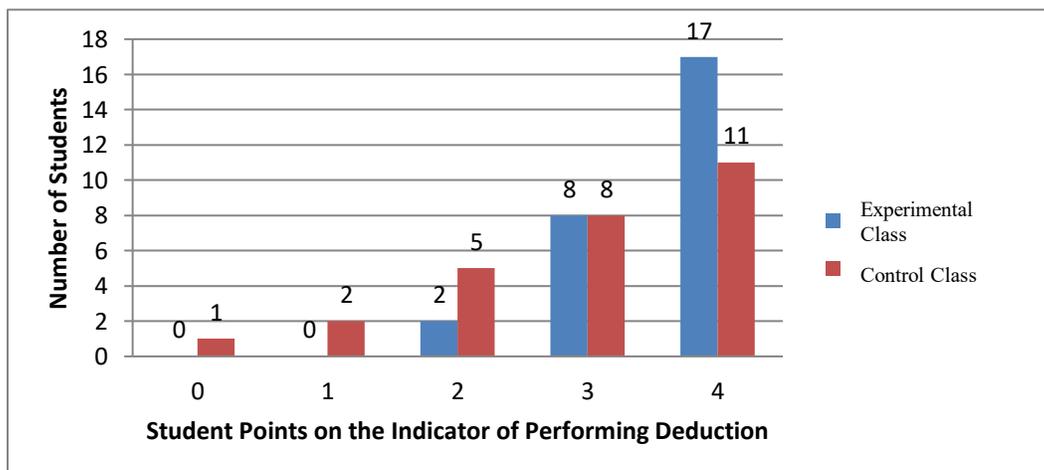


Figure 5 Comparison of Deduction Indicator

The diagram above illustrates the level of success of students in completing post-test questions using the indicator of deductive reasoning in the experimental class and the control class. According to the data on the average percentage of student scores for questions involving deductive reasoning in the experimental class, the level of student success was 89%, while the level of student success in completing questions involving argumentation in the control class was 74%.

In this study, it was found that critical thinking skills can be observed through students' ability to consider opinions, data, and facts obtained through learning activities, whether through educational videos or observations conducted. Through observation videos, students can be trained to observe practical steps and focus on the variables needed in the practical, and through direct practical activities during face-to-face sessions, they can interpret the questions in the LKPD,

which will then be discussed with the group. This aligns with the findings of Ma'rifah (2022), who stated that critical thinking skills are closely related to an individual's ability to evaluate an observation report based on evidence and information obtained.

Conducting Induction

Based on the aspect of critical thinking skills, induction is also included in the aspect of making inferences (Figure 6). This aspect focuses on deducing and considering a deduction through interpreting questions. In this study, students were given questions in the form of data from Hooke's law experiments. Then, students were asked to generalize the types of springs used.

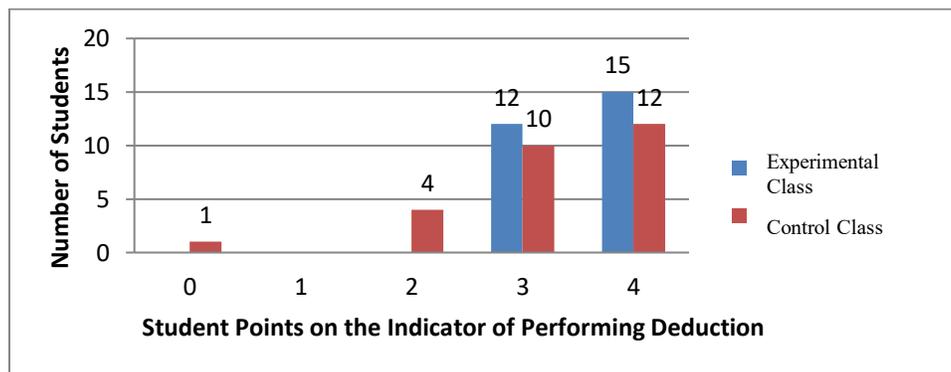


Figure 6 Comparison of Indicators for Performing Induction

The diagram above illustrates the level of success of students in completing post-test questions with indicators for performing induction in the experimental class and control class. According to the data on the average percentage of students' scores for the induction question in the experimental class, the success rate of students was 89%, while the success rate of students in completing the argumentation question in the control class was 79%. This can be trained through data processing based on observations in accordance with the LKPD provided using the problem-based learning model. In the process, students will be trained to interpret questions through observation result tables.

This aligns with research conducted by Wayudi (2019), who stated that critical thinking skills are closely related to an individual's ability to consider an

observation report based on evidence and information obtained.

Conducting Evaluation

The activity of conducting evaluations is included in the aspect of providing further learning in critical thinking skills (Figure 7). This evaluation activity is carried out by identifying terms and considering them by making interpretations and evaluating an action. In this study, the researcher provided evaluation questions in the form of providing an understanding of Hooke's law with the application of a mixed spring arrangement.

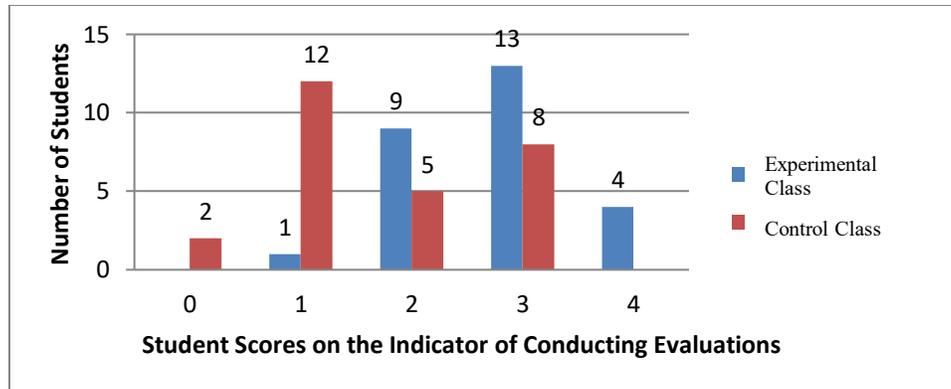


Figure 7 Comparison of Evaluation Indicators

The diagram above illustrates the level of student success in completing post-test questions using evaluation indicators in the experimental class and control class. According to the data on the average percentage of student scores for induction questions in the experimental class, the level of student success was 68%, while the level of student success in completing argumentation questions in the control class was 42%. In this study, the evaluation indicator was trained through discussions on the interpretation of data and the completion of worksheets, as well as providing feedback on the analysis of assignments contained in the learning video.

In this case, students were able to evaluate the data obtained and determine the appropriate springs to be used by practitioners. This data is consistent with Jie's research in Nuryanti (2019), which states that critical

thinkers will be able to critique, question, evaluate, and reflect on the data obtained.

Deciding and Implementing

The activity of deciding and implementing is classified under the aspect of strategizing in critical thinking (Figure 8). In this aspect of strategic planning, students are asked to determine an action by formulating a problem, selecting criteria for considering solutions, formulating alternative solutions, determining tentative actions, summarizing by considering the situation, and concluding. In this study, the researcher provided a problem in the form of selecting springs that meet the criteria and will be paired with the experiment activity.

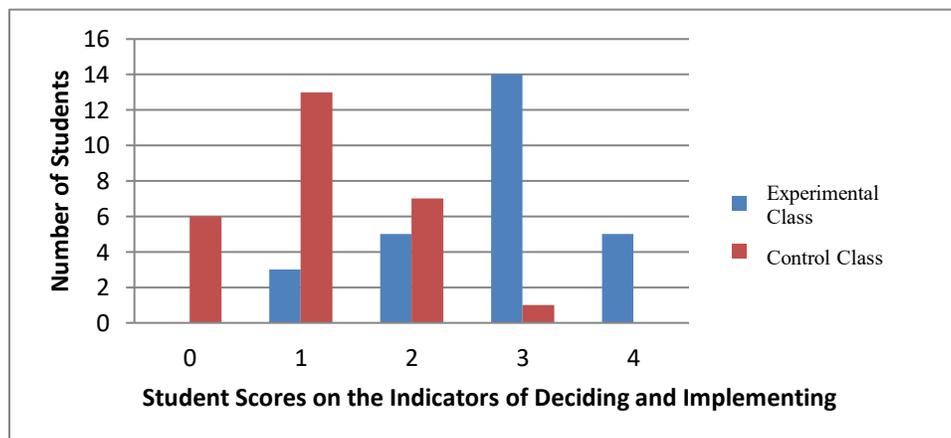


Figure 8 Comparison of Decision-Making and Implementation Indicators

The diagram above illustrates the level of student success in completing post-test questions using decision-making and implementation indicators in the experimental and control classes. According to the data on the average percentage of students' scores for

the induction questions in the experimental class, the success rate of students was 69%, while the success rate of students in completing the argumentation questions in the control class was 27%. In the learning process, the decision-making and implementation

indicators were trained through practical exercises, data processing, and discussions.

During the learning process, students can directly observe and practice and obtain data based on what has been done through practical work. This aligns with research conducted by Affandy (2019), who states that a person's reasoning regarding conceptual considerations, providing reasons based on evidence to determine further actions, and evaluating what has been implemented indicates that the person possesses higher-order thinking skills.

Based on the discussion outlined above, it can be seen that the implementation of the flipped classroom learning model assisted by instructional videos in the elasticity material can influence students' critical thinking skills. This is evidenced by the results of the hypothesis test using SPSS version 26. Prior inferential data processing was conducted as a prerequisite, including normality and homogeneity tests, to enable the hypothesis test. The data obtained from this study indicate that the data are normally distributed with a significance value greater than 0.05. The data processing can then be continued by conducting an independent sample t-test, resulting in a significance value (2-tailed) of 0.000, which can be seen in detail in Appendix 10. The hypothesis results obtained indicate that there is a significant difference in critical thinking skills between students in the experimental class that applied the flipped classroom learning model and students in the control class that applied the conventional learning model on the topic of elasticity.

4. Conclusion

Through the application of the flipped classroom learning model, students can be trained to formulate problems, provide arguments, perform deductions, perform inductions, perform evaluations, and implement and decide on actions to solve a problem. Statistically, there was a difference in scores between the experimental class and the control class. The experimental class achieved higher scores than the control class. This indicates that the flipped classroom learning method assisted by video is more effective in enhancing students' critical thinking skills compared to conventional methods. Therefore, it can be concluded that the implementation of the flipped classroom learning model assisted by instructional videos on the topic of elasticity successfully developed students' critical thinking skills compared to the implementation of conventional learning models.

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