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Flipped classroom video-based instruction to foster critical reasoning and learning independence in elementary learners

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flipped classroom;
critical thinking;
learning independence

Abstract

This study aims to analyse the effect of the flipped classroom learning model integrated with video learning on lower-class elementary school students, an area that remains underexplored empirically. Previous research generally focused on the application of flipped classrooms at the secondary and tertiary education levels, while this study adapted the model to elementary school grade III science learning by considering the characteristics of students' cognitive development through the use of simple and contextual learning videos. This study uses a quantitative method with an experimental design. The research subjects were selected based on the inclusion and exclusion criteria that had been set. Data was collected through a critical reasoning ability test and a learning independence questionnaire, then analysed using the N-Gain Score, the Independent Sample T-Test, and a simple linear regression test. The results showed that the improvement in students' ability in the experimental class (N-Gain 78.34%) was higher than that of the control class (41.94%), with an average score of 86.32 and 68.22, respectively. The regression test showed that the learning model had a significant effect on students' critical reasoning skills and learning independence. These findings suggest that video-assisted flipped classrooms are effectively applied to science learning in lower-class elementary schools.

INTRODUCTION

Background of the Study

Education is a process of acquiring knowledge individually or collaboratively to achieve meaningful and positive change. In the 21st century, rapid advances in science and technology have driven educational systems worldwide to reconsider instructional approaches that promote higher-order skills essential for contemporary learners (Hidayah & Mustadi, 2021). Although various technology-based learning innovations have been implemented to improve student engagement, many of them have not fully adapted to the classroom conditions and developmental characteristics of learners. (Sulianto et al., 2025).

This condition underscores the need for pedagogically grounded instructional models that are both innovative and contextually appropriate. From a theoretical standpoint, effective digital learning should be anchored in constructivist learning theory, which emphasises active knowledge construction through interaction, reflection, and meaningful learning experiences (Ağırman & Ercoşkun, 2022) . Digital learning environments need to be designed based on goals, competencies, and continuous assessments, but teachers still struggle to integrate technology effectively to develop high-level thinking skills due to the limitations of teacher-centred learning and practice variations. (Kartika & Wahyuni, 2023).

Critical thinking, defined as the ability to analyse, evaluate, and synthesise information to form reasoned judgments, is a core competency in 21st-century education (Cahyaningsih et al., 2024). International studies have demonstrated that student-centred instructional models grounded in self-regulated learning principles significantly contribute to the development of students' critical reasoning skills (Hoshang et al., 2021). One instructional approach that aligns with these theoretical foundations is the flipped classroom model, which shifts direct instruction outside the classroom and utilises face-to-face learning time for higher-order cognitive activities such as discussion, problem-solving, and formative feedback (Ermiana et al., 2022).

Although flipped classrooms are effective in improving critical thinking and learning independence, research at the elementary school level is still limited, especially those that tailor learning videos to students' cognitive characteristics and examine both abilities simultaneously. This study aims to examine the influence of the flipped classroom model assisted by learning videos on the critical thinking skills and learning independence of elementary school students, thereby providing contextual empirical contributions in low-grade science learning (Nasrah, 2025).

This study offers a novel empirical contribution by examining the implementation of a flipped classroom model integrated with developmentally appropriate instructional videos in lower-grade elementary science education. Unlike prior research that predominantly addresses secondary and higher education settings, this study simultaneously investigates the effects of flipped learning on elementary students' critical thinking skills and learning independence within a constructivist and self-regulated learning framework.

The Problem of The Study

The way teachers teach can influence how students become independent learners and thinkers. Not every student who can think critically is also able to learn on their own. Many students still rely on their teachers or parents for help in their learning. Learning independence plays a very important role in determining learning outcomes. (Yulianti & Wulandari, 2021). But in practice, there are still many students who have low critical thinking skills. Having the ability to think critically can distinguish the positive and negative sides, then filter the various influences that enter and adapt them to the conditions and culture of their nation. Therefore, efforts are needed to improve students' critical thinking skills. The subjects of this study were third-grade students because, according to Piaget, the cognitive development of third-grade students is at the concrete operational level, which is the initial stage of logical thinking. (Darmawati & Azizah, 2023). Thus, children are mature enough to use logical thinking. To overcome this, researchers tried to maximise the application of the flipped classroom model with learning videos to improve critical reasoning skills and learning independence of elementary school students (Pattimukay et al., 2023).

Research's State of the Art

Human development starts from the learning process at school, with the important role of teachers in educating and guiding students through the selection of learning models that are in accordance with the environmental conditions of students. Active learning and learner-centred strategies are required to promote critical thinking skills. (Nugraheni et al., 2022). The proposed model emphasises collaboration between teachers in a professional learning community, which is strengthened by the use of digital technology and supported by a tiered mentoring system.Click or tap here to enter text.

An environment-based learning model boosts student engagement by using the environment as a resource. This pedagogical approach integrates elements of both

constructivist and behaviourist learning theories within a unified platform (Afandi & Oktavia, 2025). Environmental education is more than just outdoor lessons; it focuses on the environment as a key learning tool. (Hamid et al., 2021). These activities encourage students to discover and internalise concepts based on their experiences, making learning more meaningful and memorable.

Novelty, Research Gap, & Objective

Previous studies have looked at similar topics. This research focuses on the effect of the flipped classroom model. It involved 130 participants during the USN Kolaka Academic Year 2021/2022. Researchers used non-probability sampling and picked 17 students from the class of 2020 as the experimental group. The approach is promoted as a collaborative learning technique that has qualities in the classroom. Flipped learning offers a cost-effective, student-centred approach. (Baig & Yadegaridehkordi, 2023)

The flipped classroom is a highly effective learning model for enhancing students' critical reasoning skills, applicable in both elementary and higher education. This includes creating opportunities for active learning by incorporating diverse activities both inside and outside the classroom, integrating various teaching methods, and leveraging technology to enrich the educational experience.(Nugraheni et al., 2022). Flipped learning holds significant potential for enhancing student education by fostering the development and achievement of specific and transversal competencies essential for the 21st century. These skills are essential to assist students in analysing information, solving problems, and making logical and rational.(Sari et al., 2025)

Flipped classrooms improve learners' critical thinking skills, such as clarification, support, inference, and advanced clarification. Using social media with flipped classrooms and project-based learning boosts communication and teamwork and encourages critical thinking for solving projects. (Pang, 2022). The use of the flipped classroom model can significantly influence students' learning outcomes. This study attempts to answer several research formulations as follows:

RQ1: How does the Flipped Classroom Model with learning videos affect the critical reasoning skills of grade III elementary school students?

RQ2: How does the Flipped Classroom Model with learning videos affect the learning independence of grade III elementary school students?

RQ3: How do grade III students respond after the Flipped Classroom model with learning videos is implemented?

METHOD

Type and Design

The approach used in this study is quantitative. Various quantitative method approaches consist of survey methods and experimental methods. This type of research is experimental research. The design of this research is a quasi-experimental study, namely an experiment that has a control group but cannot fully control external variables that have experimental implementation. The researcher used a quasi-experimental non-equivalent control group design (pretest-posttest control group design without randomisation). Data collection techniques used tests and questionnaires. Data analysis techniques used include Ngain Analysis, Independent T-test, and simple linear regression tests.

Data and Data Sources

This research was conducted at SDN Kalibanteng Kulon 02, which is located at Jalan Lebdosari VIII No. 1, West Semarang District, Semarang City 50148. This research was conducted in January - July 2024, Academic Year 2024/2025. The subjects in this study were all students of class III of SDN Kalibanteng Kulon 02, consisting of two classes, namely class III A (27 people) as the control class by implementing the conventional learning model and class III B (25 people) as the experimental class by implementing the flipped-classroom learning model.

Data Collection Technique

Data collection methods are chosen based on the research questions. The study used a pretest and posttest design, with control and experimental groups chosen non-randomly. One group received special treatment through the Flipped Classroom Model with learning videos, while the other group was taught using the Conventional Learning Model.

Data Analysis

After knowing the N-gain value, the value is tested in the prerequisite tests, namely the normality test and the homogeneity test. If the data from the prerequisite test shows acceptable results, then the data is worthy of being tested parametrically. The parametric test conducted in this study is the independent sample t-test. The hypothesis is formulated in the form of a statistical hypothesis (right-hand test), according to Sugiyono in the study.

Hypothesis : - If $-t < t$ count $< t$ table, then Ho is accepted

- If t count $< -t$ or t count $> t$ table, then Ho is rejected.

In addition to using the independent sample t-test (t-test), the author also uses an influence test. The influence test used in this study is the Simple Linear Regression Test. Simple linear regression is an effective analytical tool for understanding and predicting linear relationships between two variables, assuming that the relationship is truly linear and that the data meet basic statistical requirements. (Rambe et al., 2025)

This study conducted a simple linear regression test using the SPSS (Statistical Package for Social Science) version 30 with the Linear Regression Test. Before the regression test was conducted, it was necessary to fulfil the prerequisite tests, including a normality test and a linearity test. Data on the implementation of student learning independence and response analysis using a five-point Likert scale.

RESULTS

This study used the Google Scholar database to review journal articles and conference proceedings related to the flipped-classroom learning model. The study addresses two key research questions: (1) how the flipped classroom model affects students' critical reasoning skills, and (2) how it affects students' learning independence. Literature analysis shows that the flipped classroom consistently supports the development of critical reasoning by encouraging active learning, problem-solving, and classroom interaction, especially when instructional videos are used as pre-class learning materials. In addition, the findings suggest that the flipped classroom model promotes learning independence by fostering self-regulating learning behaviours, such as responsibility for pre-class preparation and active engagement during classroom activities. Based on this interpretation, this study provides a comprehensive overview of how the flipped classroom model can be effectively applied in primary school science education to improve critical reasoning and independent learning skills.

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The Flipped Classroom Model with Learning Videos Affects the Critical Reasoning Skills

As a form of an answer to the first question (RQ1), this study compared two learning models: a conventional model in the control class and a flipped-classroom model in the experimental class. The aim was to see how each model affected critical reasoning skills. The level of improvement in critical reasoning was measured through written tests given to both classes. The results of the pretest and posttest in each class can be seen in the table below:

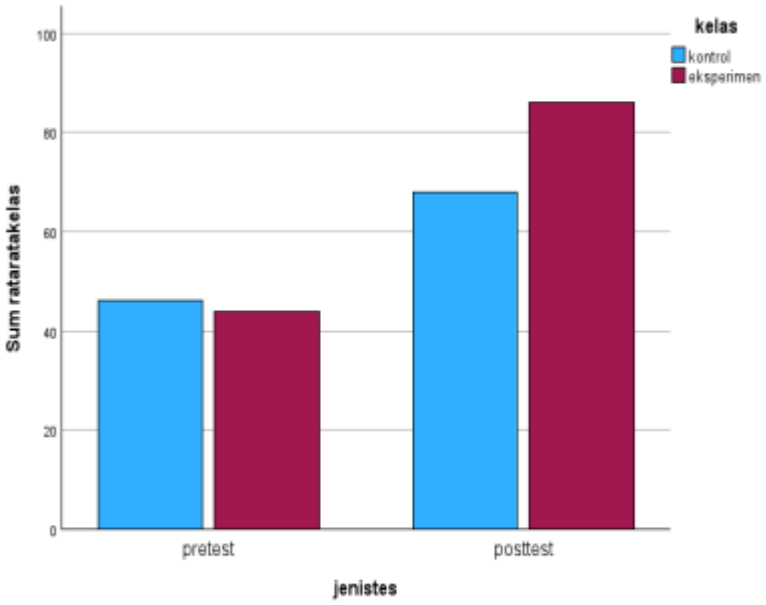


Figure 1. Percentage of pretest and posttest of the control and experimental classes

Based on the graph, the pre-test and control class scores increased by 33.01%. While the average pretest and posttest of the experimental class increased by 49.54%. The test results can then be compared through the N-gain Score test, where the N-gain score aims to determine the effectiveness of using a method or treatment. The results of the N-gain score calculation in this study can be seen in the following table.

Table 1: Results of the N-gain score analysis of the control class

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Ngain_Score	27	.09	1.00	.4194	.18809
Ngain_Persen	27	8.51	100.00	41.9350	18.80870
Valid N (listwise)	27				

Table 2. Results of the N-gain score analysis of the experimental class

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Ngain_Score	25	.46	1.00	.7834	.18071
Ngain_Persen	25	46.25	100.00	78.3429	18.07119
Valid N (listwise)	25				

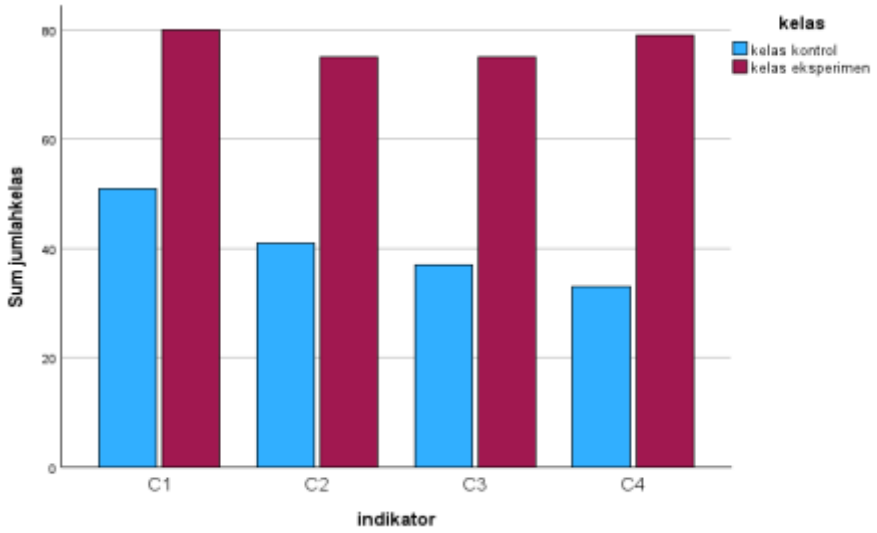


Figure 2. Percentage of pretest and posttest values for each indicator aspect

The mean value for the N-gain score of the experimental class is 0.7834, which is rounded to 0.783, meaning that the value is in the interpretation criteria of 0.70-1.00, namely, the effectiveness value is high. The N-gain per cent in the experimental class is 78.3429, which is rounded to 78.34 per cent, meaning that the value is in the effectiveness interpretation criteria > 76 per cent, namely effective. The graph above shows that the N gain for the C1 indicator aspect is the highest value for increasing the average value of both the control class and the experimental class.

After knowing the N-gain value, the value is tested in the prerequisite test, namely the normality test and the homogeneity test. The normality test is used to determine whether the sample data comes from a normally distributed population or

not. To determine the normality of the data, SPSS version 30 is used. The normality test uses the Kolmogorov-Smirnov test. The homogeneity test aims to test whether the sample data taken is homogeneous or not from the same population. To test the homogeneity of the sample, the Levene test is used in SPSS version 30.

Table 3. Results of Data Normality Test Analysis

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
pretest kontrol	.093	25	.200*	.960	25	.409
posttest kontrol	.131	25	.200*	.959	25	.396
posttest eksperimen	.157	25	.114	.934	25	.108
pretest eksperimen	.098	25	.200*	.971	25	.659

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Table 4. Results of the Homogeneity Test analysis

Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
Nilai	Based on Mean	1.462	1	50	.232
	Based on Median	1.453	1	50	.234
	Based on Median and with adjusted df	1.453	1	50.000	.234
	Based on trimmed mean	1.400	1	50	.242

Based on Table 3, it is known that the sig. (2-tailed) value produced on the control class pretest data is 0.409, and the posttest is 0.396 and the significance. The value is 0.200. Data is said to be homogeneous if the sig. The value produced is more than 0.05. The results of the homogeneity test in Table 4 show that the data in this study are homogeneous. After the data is said to be normal and homogeneous, the parametric test, namely the T test (independent sample T-Test), is used. The average post-test results of the experimental class and control class can be seen in the following statistical table 5.

Table 5. Results of hypothesis test analysis (Independent t-Test)

Group Statistics

	Kelas	N	Mean	Std. Deviation	Std. Error Mean
Hasil	Posttes eksperimen	25	86.32	12.857	2.571
	Posttes kontrol	27	68.22	10.804	2.079

In this study, the influence test was conducted using a simple linear regression test with the help of the SPSS program. Before conducting a simple linear regression test, a prerequisite test was conducted, namely, the linearity test.

The linearity test results show that the significance value for variable X (learning model) concerning variables Y1 (critical reasoning) and Y2 (independence learning) is above 0. 05. Additionally, Fcount is less than Ftable 3. 44. The deviation from linearity for X against Y1 is 0. 075 with an Fcount of 2. 960, and for X against Y2, it is 0. 539 with an Fcount of 0. 992. This indicates the data is linear, allowing for a simple linear regression test. The simple linear test will assess the effect of an independent variable on a dependent variable by determining the correlation value and coefficient of determination in the experimental class. The results of the simple linear regression test can be seen in Tables 7 and 8 below:

Table 6. Results of the simple linear regression test analysis of the Learning Model on the Critical Reasoning Level

ANOVAa

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	878.783	1	878.783	9.069	.006[b]
	Residual	2228.577	23	96.895		
	Total	3107.360	24			

Table 7. Results of the simple linear regression test analysis of the Learning Model on student learning independence

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	306.903	1	306.903	8.671	.007[b]
	Residual	814.057	23	35.394		
	Total	1120.960	24			

a. Dependent Variable: kemandirian

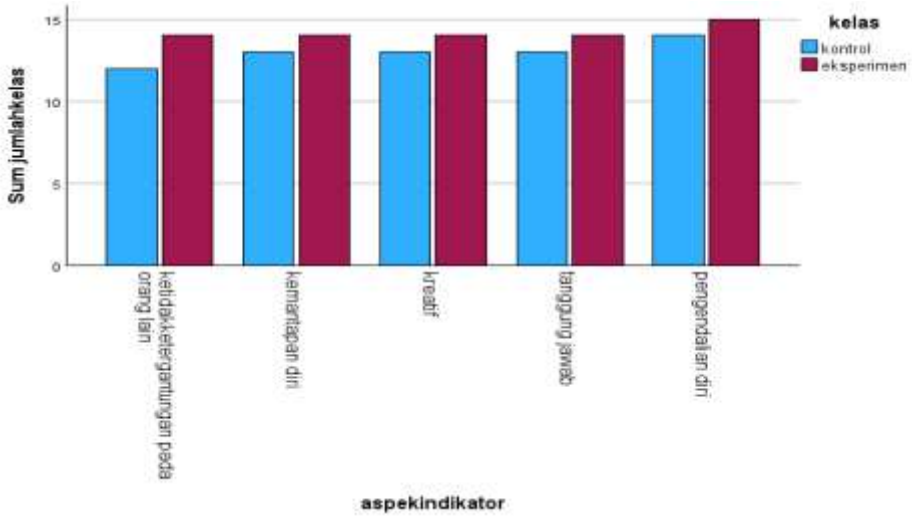
b. Predictors: (Constant), model

Based on the results of the analysis of Table 7 above, it is known that the significance level is 0.006 <0.05 for the influence of the flipped classroom model on critical reasoning skills. According to the results of the analysis of Table 8 above, it is known that the significance level is 0.007 <0.05 for the influence of the flipped classroom model on student learning independence.

A. Independence Analysis

The second research question (RQ2): The results of the analysis of student learning independence in the control class regarding the implementation of the flipped classroom learning model were analyzed using descriptive percentages, the results of which are presented in the graph below:

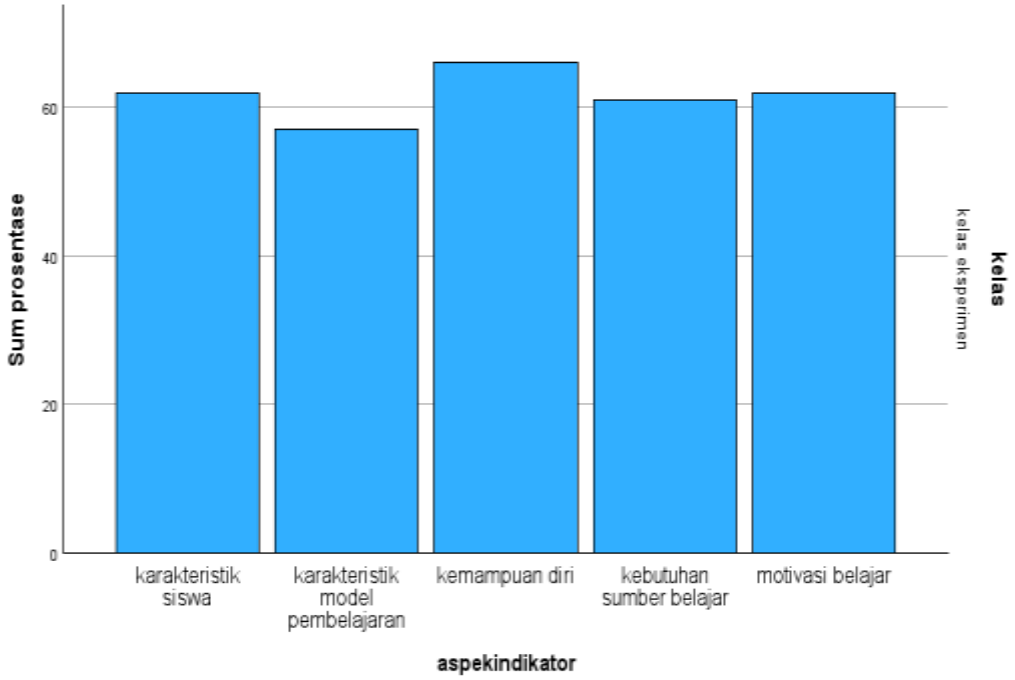
Figure 3. Percentage of independence analysis



B. Resonance analysis

Next, the results obtained to answer the third research question (RQ3) are in the graph below :

Figure 4. Percentage of analysis of student responses



DISCUSSIONS

The findings of this study demonstrate that the flipped classroom learning model integrated with instructional video media leads to significantly better learning outcomes compared to conventional lecture-based instruction. The experimental group showed a higher increase in average scores and a moderate N-gain value (0.419), indicating meaningful improvement in students' critical thinking skills. These results can be explained through constructivist learning theory, which emphasises active knowledge construction through meaningful learning experiences. In the flipped classroom, students engage with learning materials before class and use class time for discussion, problem-solving, and reflection, allowing them to construct deeper understanding rather than passively receive information.

From the perspective of cognitive theory and Socioscientific Issues (SSI) learning, the flipped classroom enables students to analyse real-world problems, evaluate information sources, and consider multiple viewpoints (Made et al., 2022). The higher proportion of students scoring above the class average in the experimental group (40%) compared to those below average (35%) further indicates that the flipped classroom supports differentiated cognitive development, allowing students with varying abilities to progress at their own pace (Riska et al., 2024).

Statistical analysis confirms the effectiveness of the flipped classroom model. The data were normally distributed and homogeneous, meeting the assumptions for parametric testing. The independent sample t-test revealed a significant difference in post-test scores between the experimental and control groups, with the experimental class achieving a substantially higher average score (86.32) than the control class (68.22). The linear regression analysis further demonstrated a significant positive effect of the flipped classroom on critical thinking skills (sig. = 0.006). These findings align with (Syarah, 2023). who reported that flipped classroom implementation significantly improves elementary students' mathematical reasoning skills. Together, these results suggest that flipped learning consistently enhances higher-order thinking across different subject areas.

The success of flipped classrooms can be explained through the theory of self-regulated learning, which shows that students in experimental classes have higher learning independence than control classes. These findings support (Fatimah et al., 2022), who found that more than 57% of students experienced increased self-

directed learning through flipped classroom implementation. By requiring students to access instructional videos independently before class, the flipped classroom fosters responsibility, time management, and learning ownership.

Flipped classroom supports differentiated learning through videos that allow students to learn at their own pace and teacher guidance in the classroom according to individual needs, thereby increasing the fairness of learning outcomes and critical thinking skills. Students' positive response to the flipped classroom model shows a high acceptance rate and confirms its effectiveness. These findings are consistent with (Hoshang et al., 2021) and (Atwa et al., 2022), who reported that flipped classrooms enhance student–teacher interaction, reduce learning anxiety, and increase student engagement. The perceived accessibility and usefulness of technology also contributed to students' motivation and enthusiasm for learning.

In summary, the flipped classroom model is effective because it integrates constructivist, self-regulated, and differentiated learning principles. By promoting active engagement, independent learning, and personalised instruction, the flipped classroom creates a learning environment that supports critical thinking development and learning independence. These findings provide meaningful implications for elementary science education and offer strong theoretical and empirical support for adopting flipped classroom approaches in differentiated learning contexts.

CONCLUSION

The results of this study show that the flipped classroom learning model integrated with instructional videos significantly improves elementary students' critical reasoning skills and learning independence in science learning on changes in the state of matter. Critical reasoning skills increased by 49.54% with a high N-gain value of 0.783, while learning completeness reached 92% after the implementation of the model. In addition, 72% of students demonstrated improvement in learning independence, supported by a significant influence test (sig. = 0.007). Positive student responses further indicated that the flipped classroom made science learning more meaningful and engaging. These findings imply that the flipped classroom model can be effectively applied by elementary teachers to foster higher-order thinking and self-directed learning. Future studies are encouraged to examine the long-term effects of this model, extend its application to other science topics, and investigate its effectiveness across diverse educational contexts.

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