



The Effect of Animated Video Learning Media on Students' Understanding and Independence in the Subject Science Lesson

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Abstract

This study aimed to examine the effect of animated video learning media on the conceptual understanding and learning independence of fourth-grade students in Natural and Social Sciences at Kraton 2 Elementary School in Bangkalan. This study employed a quantitative approach with a quasi-experimental design using a non-equivalent control group. The research sample consisted of one experimental group that learned using animated videos and one control group that received conventional instruction without animated video media. The instruments used in this study were a conceptual understanding test and a learning independence questionnaire. The data were analyzed using descriptive statistics, an independent samples t-test, effect size analysis, and MANOVA. The findings showed that the experimental group's conceptual understanding scores increased from 39.12 to 72.00, while the control group's scores increased from 28.56 to 44.64. In terms of learning independence, the experimental group's scores increased from 28.12 to 57.84, whereas the control group's scores increased from 28.36 to 31.12. The independent samples t-test showed statistically significant differences in both variables ($p < 0.001$). These findings were further supported by large effect sizes, with Cohen's $d = 2.014$ for conceptual understanding and Cohen's $d = 3.218$ for learning independence. The MANOVA results based on Pillai's Trace indicated that class had a significant simultaneous effect on students' conceptual understanding and learning independence ($p < 0.001$). These findings suggest that animated video learning media can serve as an effective supplementary medium in Natural and Social Sciences learning, although the interpretation of the results should be limited to the context of this study.

Keywords: Animated video learning media; Understanding; Independence; Science learning; Elementary school students

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INTRODUCTION

Education is very important for creating high-quality and competitive individuals (Rizky Asrul Aniswita et al., 2022). Law Number 20 of 2003 in Indonesian states that education is a deliberate and purposeful effort to help students reach their full potential and shape the character of the nation (Munir et al., 2022). In 2016, the Ministry of Education and Culture Indonesian emphasized the importance of developing 21st-century skills so that students can adapt to changes around the world (Septikasari & Frasandy, 2018). This is then reflected in the Merdeka Curriculum, which combines the disciplines of Natural Sciences and Social Sciences into Natural and Social Sciences for elementary school students (Andreani & Gunansyah, 2023). the natural and social sciences learning aims to help students understand how natural and social events are interconnected and to learn more about the world around them (Kemdikbudristek, 2022). This integrated learning aligns with the way elementary school

students think, which is usually concrete and holistic, and therefore should help them understand ideas thoroughly (Purnawanto, 2022). However, the implementation of natural and social sciences learning in practice faces several issues, including the prevalence of teacher-centered pedagogy, a tendency toward mechanical memorization, and a lack of use of interactive and contextual learning resources (Susilowati, 2023). Because of this, students have not fully understood the subjects they are researching (Dauliy et al., 2024).

Learning independence has emerged as a critical factor in assessing student performance in participating in natural and social sciences learning (Suhandi & Kurniasri, 2019). Learning independence is closely related to students' readiness before engaging in learning activities and can affect both the effectiveness of the learning process and overall educational outcomes (Afid et al., 2024). Self-confidence, responsibility, initiative, and the ability to manage research time well indicate that someone can learn independently (Alfiatunnisa et al., 2022). Laksana & Hadijah (2019) state that learning independence is when students perform learning tasks on their own, without seeking support from others. Dedyerianto (2020) also states that self-directed learning behavior is demonstrated by the ability of students to achieve their learning goals without seeking help from classmates in schoolwork. Learning independence with self-driven characteristics motivated by intrinsic desire will substantially affect students' educational outcomes (Bramantha, 2019).

In the context of natural and social sciences learning, it is important to have a good understanding of the subject matter as well as to facilitate learning freedom. In natural and social sciences learning, conceptual understanding means that students can comprehend the ideas, conditions, and facts they are researching. In this way, they do not just memorize information; they truly understand it (Walangadi & Putra Pratama, 2018). Deep understanding is crucial in building students' knowledge frameworks and facilitating their performance in subsequent learning phases (Nikmah, 2016). Learning is an important part of how students understand something because it helps them connect what they learn with their own experiences (Zhao et al., 2022). Students will struggle to use what they have learned in everyday life or in other learning situations if they do not understand it well (Usanto, 2022). So, appropriate learning media has a significant impact on how well children understand (Widiana, 2022). Using the right media can help organize information in a more engaging and easily understandable way (Alit et al., 2021) and can have a positive effect on students' mental health (Rahayu et al., 2019).

One way to help students understand and learn independently is by using animation-based learning materials specifically designed for elementary school students (Binta et al., 2023). Animated video media, which combines sound and images, can transform abstract ideas into something more tangible and easier to understand (Imarah & Darul, 2016). Additionally, using this type of media can help students pay more attention and become more engaged in the learning process. This can also motivate them to learn independently by providing flexible access and the ability to repeat content as needed (Pradana, 2025). So, animated videos can help students learn independently and also help them understand concepts better (Subhan et al., 2025).

Various studies from the past have shown that animated videos are beneficial for learning. The research by Kumalasari & Arifin (2024) shows a substantial effect of animated videos on students' understanding and learning independence, as indicated by the Paired Sample T-Test with a significance value of $0.000 < 0.05$. Siti et al. (2025) showed an improvement in students' natural and social sciences learning outcomes after the introduction of animated videos, as indicated by the t-test findings that revealed a significant difference between pre-treatment and post-treatment assessments. Aulia et al. (2025) found that the use of digital animated video media significantly affects students' natural and social sciences learning outcomes, with a significance value of $0.008 < 0.05$ based on an independent t-test. Herlinawati et al. (2024) also found similar results, confirming that animated videos have a

significant impact on students' scientific learning outcomes with a significance value of $0.000 < 0.05$. However, although some studies show the effectiveness of animated videos in education, most of these studies only assess one aspect of the consequences, whether it is related to understanding or independent learning separately. Most of the time, only t-tests are used, so there has been no research that examines both outcomes simultaneously in a multivariate analysis for fourth-grade elementary school students, especially in Bangkalan. Therefore, this research aims to address the existing gap by investigating the impact of animated videos on two interrelated variables: understanding of natural and social sciences learning and learning independence, simultaneously thru multivariate analysis (MANOVA).

The initial results from Kraton 2 Elementary School in Bangkalan indicate that natural and social sciences learning at the school is still largely traditional, which exacerbates the problem. The students are not fully engaged in the learning process, and they struggle when asked questions that test their conceptual understanding. This indicates that the students still do not fully comprehend the natural and social sciences subject and that they need to learn to be more independent. So, the aim of this research is to determine whether the use of animated video media can help students at Kraton 2 Elementary School in Bangkalan better understand the material and learn independently. As a result, this research aims to improve the progress of natural and social sciences education in elementary schools and encourage greater student autonomy in their learning process.

The hypothesis of this research argues that:

1. First, the use of animated video media significantly affects students' understanding of natural and social sciences learning.
2. Second, the use of animated video media noticeably affects students' learning independence.
3. Third, the simultaneous application of animated video media has a substantial impact on both variables.

The research aim to produce data that will enhance natural and social sciences learning practices in elementary schools and provide new insights into the development of more effective learning media.

METHOD

Research Design

This research employs a quantitative methodology with a quasi-experimental design of the nonequivalent control group pretest-posttest type. This approach was chosen based on the use of two intact classes, namely class IV-A and IV-B, without randomizing individual students into the research groups. Class IV-A was assigned as the experimental group using natural and social sciences learning facilitated by animated videos, while class IV-B served as the control group using traditional techniques for natural and social sciences learning. this design was used to evaluate changes in understanding of natural and social sciences learning and student autonomy in learning before and during the intervention. The research process includes participant recruitment, group allocation, pretest administration, treatment implementation, and posttest administration. The research design conducted can be seen in the Figure 1.

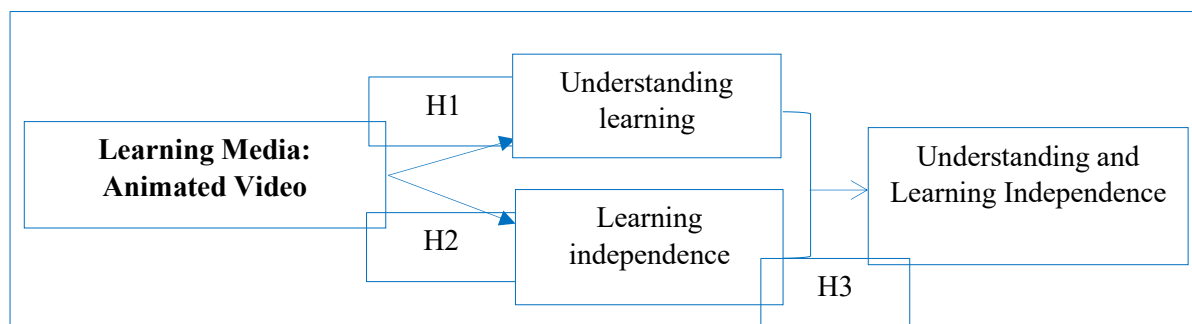


Figure 1. Research design

Participants and sampling

The research subjects are 50 fourth-grade students from Kraton 2 Elementary School in Bangkalan, including 25 students in class IV-A and 25 students in class IV-B. The sampling method used is saturated sampling, which means all students from both classes participate as research subjects. The inclusion criteria for this research include students who are currently enrolled in the semester, engaged in natural and social sciences learning on relevant topics, and attended the pretest, treatment, and posttest phases. The research narrative must report participants' demographic data, including age, gender, and attendance rate during the intervention, to provide a comprehensive overview of the sample characteristics. The comparison of initial skills among the groups was assessed using pretest scores before the treatment was administered.

Research Intervention

The intervention in this research uses animated video learning media in the natural and social sciences class. The media used consists of animated videos tailored to the learning objectives of the natural and social sciences subject for fourth grade, specifically discussing the material "forces around us." The animated video is compiled into one video lasting about 10 minutes and is used in one session. The structure of the video content consists of learning objectives, apperception, exposition of key concepts, contextual examples relevant to students' lives, practice or prompting questions, and a summary conclusion of the information. The film's narrator uses simple and easily understandable language appropriate for the developmental stage of elementary school children. This video employs dynamic images, striking fonts, symbols, and colors that reinforce the emphasis on concepts, while the audio components consist of narration and balanced background music to maintain learning focus. The film was presented through an LCD projector and uploaded to the YouTube application to allow students to access it again as needed. The control group examined identical natural and social sciences content with equivalent time allocation, but without animated videos, instead relying on teacher explanations, textbooks, and class discussions. The uniformity of treatment was maintained through the same teacher, the same learning protocol, and the implementation observation sheet, allowing variations in learning outcomes to be more directly linked to the use of media.

The animated video shown is the "Forces" animation created by a YouTube channel called "kejarcita" and used in the experimental class with the following animation visuals.



Figure 2. Visualization of the animated video used in the experimental class

The established learning objectives require students to articulate the concept of force, identify various forms of force, and understand the impact of force on objects in everyday life. The practice begins with apperception that involves connecting students' real-life experiences, such as pushing a table, pulling a door, or kicking a ball, with the concept of force. This learning

aims to spark interest and foster a connection between personal experiences and the subject matter to be studied.

Next, animated videos are used to explain the basic topics. Students are introduced to the definition of force as a push or pull, with several types of forces including muscular force, gravitational force, frictional force, and magnetic force, as well as the impact of these forces on objects, which can result in changes in motion, direction, or shape. Basic visual representations, illustrated thru Budi's cycling narrative, facilitate students' understanding of complex topics thru visuals that resonate with their everyday experiences.

To enhance understanding, the teacher provides additional relevant contextual examples, such as the action of opening a door, pulling a chair, or a ball stopping after being kicked. The students are then given exercises in the form of provocative questions, such as: "Why does the ball stop moving after being kicked?" or "What happens if the applied force exceeds the frictional force?" These questions encourage critical thinking among students while simultaneously developing their autonomy in seeking solutions.

The activity concluded with a brief summary, which showed that force is a push or pull that affects an object, exists in various forms, and is present in daily activities. This summary enhances conceptual understanding while emphasizing the importance of self-directed learning thru reflection and direct experience.

Research Instruments

The research instruments consist of two types: the natural and social sciences learning comprehension test and the learning independence questionnaire. The natural and social sciences learning comprehension test assesses students' understanding of the ideas presented before and during the intervention. This assessment consists of 20 multiple-choice items organized according to understanding indicators. The test results are provided according to the assessment criteria. The learning independence questionnaire assesses students' tendency to learn independently throughout the educational process. This questionnaire contains 20 statements that use a 1-5 likert scale designed according to the indicators of learning independence.

The quality of the instrument is assessed before being used in the research. The validity of the items in the questionnaire and survey is established thru expert evaluation by expert validators. The validity of the test items can be assessed using methods such as product-moment correlation or Aiken's V coefficient, depending on the procedure used, while the reliability of the instrument is determined using the Cronbach's alpha coefficient for questionnaires and KR-20/Cronbach's alpha for tests, with specific reliability values provided.

Research Procedure

The research process begins with obtaining permission from the school and getting approval from parents or guardians for the child's participation in the research. The research was then conducted thru several stages. The initial stage involved conducting a pretest of natural and social sciences understanding and distributing a learning independence questionnaire to both groups to assess the students' baseline conditions. The second step involved delivering the lesson to the experimental group using animated videos, while the control group followed traditional teaching techniques covering the same content over an identical period. The third stage involves conducting a posttest and reissuing the learning independence questionnaire after all treatments are completed. Incomplete student data at any step must be explicitly addressed, for example, thru listwise deletion or other relevant methodologies, to ensure that data analysis remains accessible and traceable.

Research Data Analysis

Data analysis was conducted using IBM SPSS software version 27 for Windows. The initial stage of the analysis involves assessing the validity and reliability of the instruments, followed by normality and homogeneity tests as prerequisites for the analysis. The equivalence

of initial skills between the experimental and control groups was assessed using pretest score analysis. Hypothesis testing for each dependent variable was conducted using an independent samples t-test to examine differences in natural and social sciences learning comprehension and learning independence between the two groups at the end of the treatment, while simultaneous hypothesis testing was conducted using multivariate analysis of variance (manova). This analysis aims to determine whether there are significant differences in students' natural and social sciences learning comprehension and learning independence between the experimental and control groups collectively. The analysis report should include effect sizes, such as cohen's d for the t-test and partial eta squared for MANOVA, to facilitate a deeper interpretation of the intervention's impact strength.

RESULTS AND DISCUSSION

Results

This research will analyze and determine the effect of the use of animated video learning media on the understanding and learning independence of fourth-grade students in science at the Kraton 2 Elementary School in Bangkalan. Data analysis in this research was conducted using several statistical tests.

The analysis of the relationship between the use of animated video media and the learning comprehension of grade 4 students was carried out using the independent sample t-test hypothesis test with the following analysis results.

Table 1. Statistical Analysis of Average Scores of Students' Understanding Learning

	Class	N	Mean	Std. Deviation	Std. Error Mean
Pretest	Eksperiment's Class	25	39.12	22.189	4.438
	Control's Class	25	28.56	18.353	3.671
Postest	Eksperiment's Class	25	72.00	13.077	2.615
	Control's Class	25	44.64	14.080	2.816

Statistical analysis of Table 1 reveals that at the pretest stage, the experimental class had an average score of 39.12, while the control class scored 28.56. This difference indicates that before the treatment, the understanding of students in the experimental group was slightly better compared to the control group, but both remained within a low range. After the treatment, the experimental group showed a significant improvement, reaching an average posttest score of 72.00. Meanwhile, the control group only increased to 44.64. The experimental class showed an increase of 32.88 points, far exceeding the 16.08 point increase observed in the control class. This proves that the animated videos applied in the experimental class were more effective in improving students' understanding. The standard deviation in the experimental class decreased from 22.189 to 13.077, indicating that students' learning outcomes became more uniform after the intervention. The Table 2 displays the results of the independent sample t-test.

Table 2. Results of independent sample t-test on the understanding learning variable

Variable	Variance Assumption	Levene's Test F	Levene's Sig.	t	df	Sig.	Mean Diff.	SE	95% CI	
									Lower	Upper
Understanding	Equal variances assumed	0.020	0.888	7.119	48	0.000	27.36	3.843	19.633	35.087
	Equal variances not assumed			7.119	47.74	0.000	27.36	3.843	19.632	35.088

The results of the independent sample t-test on learning comprehension, as presented in Table 2, show a significance value of 0.000, which is less than $p = 0.05$. As a result, there is a significant gap in the use of animated video learning media regarding learning comprehension in Class 4 Kraton 2 Elementary School in Bangkalan, leading to the acceptance of H_a and the rejection of H_0 . The results of the Independent Samples Effect Sizes analysis on the learning comprehension variable can be seen in the Table 3.

Table 3. Results of Independent Samples Effect Sizes on the learning comprehension variable

		Standardizer ^a	Point Estimate	95% CI	
				Lower	Upper
Understanding	Cohen's d	13.587	2.014	1.322	2.691
	Hedges' correction	13.805	1.982	1.301	2.649
	Glass's delta	14.080	1.943	1.154	2.711

The findings of the Independent Samples Effect Sizes analysis for the learning comprehension variable reveal a relatively large effect size. Cohen's d is 2.014, with a 95% confidence interval ranging from 1.322 to 2.691; Hedges' g is 1.982, with an interval from 1.301 to 2.649; and Glass's Δ is 1.943, with an interval from 1.154 to 2.711. All three effect sizes consistently fall into the very large category according to Cohen's convention, indicating that the difference between the comparison groups regarding learning comprehension is statistically significant. The results of the hypothesis test using an independent samples t-test on learning independence are as follows.

Table 4. Statistical Analysis of Average Values of Students' Learning Independence

	Class	N	Mean	Std. Deviation	Std. Error Mean
Pretest	Eksperiment's Class	25	28.12	9.488	1.898
	Control's Class	25	28.36	5.567	1.113
Posttest	Eksperiment's Class	25	57.84	10.586	2.117
	Control's Class	25	31.12	5.085	1.017

Statistical analysis shows that the initial level of learning independence among students in the experimental class and the control class is comparable. The average pretest scores were almost the same, namely 28.12 in the experimental class and 28.36 in the control class. However, after the intervention, a striking difference emerged. The average posttest score of the experimental class significantly increased to 57.84, while the control class only reached 31.12. The experimental class experienced a significant increase of 29.72 points, in stark contrast to the control class's growth of only 2.76 points. This proves that the treatment or animated video applied in the experimental class significantly influenced the improvement of students' learning independence. The Table 5 displays the results of the independent sample t-test.

Table 5. Results of the independent sample T-test on the learning independence variable

Variable	Variance Assumption	Levene's Test F	Levene's Sig.	t	df	Sig.	Mean Diff.	SE	95% CI	
									Lower	Upper
Independence	Equal variances assumed	6.103	.017	11.376	48	.000	26.720	2.349	21.998	31.442
	Equal variances not assumed			11.376	34.517	.000	26.720	2.349	21.949	31.491

The results of the independent sample t-test on learning independence, as presented in Table 4, show a significance value of 0.000, which is less than p = 0.05. As a result, there is a significant gap in the use of animated video learning media about learning independence in Class 4 Kraton 2 Elementary School in Bangkalan, leading to the acceptance of Ha and the rejection of H0. The results of the Independent Samples Effect Sizes analysis on the learning independence variable can be seen in the Table 6.

Table 6. Results of Independent Samples Effect Sizes on the learning independence variable

		Standardizer ^a	Point Estimate	95% CI	
				Lower	Upper
Independence	Cohen's d	8.304	3.218	2.362	4.058
	Hedges' correction	8.437	3.167	2.325	3.994
	Glass's delta	5.085	5.254	3.669	6.824

The results of the Independent Samples Effect Sizes for the variable of learning independence show that the effect size is substantial and consistent. The Cohen's d value is 3.218, with a 95% confidence interval ranging from 2.362 to 4.058. Hedges' g is 3.167, with an interval from 2.325 to 3.994. Δ Glass is 5.254, with an interval from 3.669 to 6.824. All three effect sizes exceed the "large" category according to Cohen's standards, indicating that the differences between the compared groups regarding learning independence are statistically significant.

The next analysis, namely the relationship between the use of animated video media and the understanding of learning and independence of grade 4 students, was carried out using the Manova test with the analysis results in Table 7.

Table 7. Results of Multivariate Analysis of Variance (MANOVA) Hypothesis Test on the variables of student understanding and independence

Analysis Component	Effect / Variable	Test / Basis	Value	F	df1 / Hypothesis df	df2 / Error df	Sig.	
Box's Test of Equality of Covariance Matrices		Box's M	12.651	4.027	3	414720.000	.007	
		F						
Multivariate Tests	Intercept	Pillai's Trace	.977	1009.670 ^b	2.000	47.000	.000	
		Wilks'	.023	1009.670 ^b	2.000	47.000	.000	
		Lambda						
		Hotelling's Trace	42.965	1009.670 ^b	2.000	47.000	.000	
		Roy's	42.965	1009.670 ^b	2.000	47.000	.000	
		Largest Root						
	Class	Pillai's Trace	.769	78.208 ^b	2.000	47.000	.000	
		Wilks'	.231	78.208 ^b	2.000	47.000	.000	
		Lambda						
		Hotelling's Trace	3.328	78.208 ^b	2.000	47.000	.000	
		Roy's	3.328	78.208 ^b	2.000	47.000	.000	
		Largest Root						
	Levene's Test of Equality of Error Variances	Understanding	Based on Mean	.020		1	48	.888
			Based on Median	.009		1	48	.925
Based on Median and with adjusted df			.009		1	46.427	.925	
Based on trimmed mean			.008		1	48	.927	
Independence			Based on Mean	6.103		1	48	.017
Based on Median		1.393		1	48	.244		
Based on Median and with adjusted df		1.393		1	30.668	.247		
Based on trimmed mean		3.861		1	48	.055		

The results of the MANOVA test for students' understanding and learning independence reveal that the assumption of equal covariance matrices among groups is violated, as indicated by the significant Box's M test value of 0.007, which is below 0.05. Consequently, the results are more accurately interpreted using the stronger Pillai's Trace. The multivariate test for the Intercept effect yields a significance level of 0.000 across all measures, affirming the overall relevance of the model. The Pillai's Trace value of 0.769, with $F = 78.208$ and significance 0.000, indicates a highly significant effect of the class on the variables of students' understanding and learning independence. Therefore, it can be concluded that the class significantly affects both variables.

Discussion

The Influence of Animated Videos on Learning Comprehension

Research findings indicate that students in the class using animated videos experienced a greater improvement in learning comprehension compared to students in the control class. The average understanding score of the experimental group increased from 39.12 on the pretest to 72.00 on the posttest, while the control group increased from 28.56 to 44.64. The experimental class experienced an increase of 32.88 points, surpassing the control class, which only increased by 16.08 points. The independent sample t-test confirmed these findings, with a significance value of 0.000 ($p < 0.05$), indicating that the difference between the groups is statistically significant. The effect size for the understanding variable is categorized as very substantial, as seen in Cohen's $d = 2.014$, Hedges' $g = 1.982$, and Glass's $\Delta = 1.943$. These results indicate that the use of animated videos correlates with an increase in conceptual understanding in this research environment.

The results of this research are in line with previous research that shows that animated videos enhance clarity, context, and information comprehension for students. Kumalasari & Arifin, (2024) show that animated video media assist educators in delivering content, are relevant to learning objectives, and align with curricula that prioritize student-centered learning activities. Research by Dinda et. al (2024) indicates that the use of learning media, namely animated videos, enhances teachers' ability to present information dynamically and facilitates students' understanding of the topic. These findings are supported by Feby Amelia & Rury Rizhardi (2025), who found that animated video learning media positively affects the academic performance of fifth-grade students in the natural and social sciences subject. Putu et al. (2024) have observed that animated videos in natural and social sciences learning provide benefits, particularly in helping students understand evidence-based content and facilitating the achievement of educational goals.

These results can theoretically be understood thru the lens of constructivism. Piaget and vygotsky view learning as an active process in which students generate knowledge thru experience, interaction, and guidance. In this paradigm, animated videos serve as a medium that makes abstract concepts more tangible, thereby assisting students in meaning-making (Nurjamilah, 2025). Research conducted by Suliyati et. al (2023) shows that animated videos using problem-solving strategies can enhance students' cognitive and problem-solving skills. Therefore, the most reliable conclusion from this research is that animated videos offer visual representations that can aid in the processing of ideas, rather than clearly enhancing motivation or self-regulation. This explanation is in line with the findings of Tantowie et al. (2024), which show that animated videos can enhance learning by presenting content that is more visual, engaging, and easy to understand.

The Influence of Animated Videos on Learning Independence

Research findings indicate a significant difference between the two groups in the characteristics of learning independence. The initial scores of both classes were comparable, with 28.12 in the experimental class and 28.36 in the control class. After the intervention, the average learning independence score in the experimental class increased to 57.84, while the

control class only reached 31.12. The experimental class experienced an increase of 29.72 points, far exceeding the 2.76-point increase observed in the control class. The independent sample t-test revealed a significance value of 0.000 ($p < 0.05$), indicating a statistically significant difference. The effect size is substantial, with Cohen's $d = 3.218$, Hedges' $g = 3.167$, and Glass's $\Delta = 5.254$. The findings indicate that the use of animated videos in this research is correlated with higher learning independence scores compared to the control group. This research assessed learning independence using a questionnaire, leading to the conclusion that the differences in learning independence scores are clearly visible as indicated by the instrument. As a result, the statement that students show an increase in independence, activity, or responsibility should be expressed proportionally. This research has not yet explicitly assessed self-regulation, learning techniques, time management, or students' intrinsic motivation. As a result, the relationship between conceptual understanding and learning independence in this research is more accurately described as an empirical correlation between the two assessed variables, rather than as evidence of a direct causal relationship.

The findings of this research can be compared with the research by Nurfidia Azhari et. al (2023), which shows a good correlation between self-directed learning and the conceptual understanding ability of elementary school students. The reference is very important for enhancing understanding, although it must be distinguished from the findings of this research. The same applies when relating the results to the research of Caella et. al (2024) and Mita Aswatun & Halimatus, (2025). Both studies show that animated videos can capture students' attention, create an enjoyable learning atmosphere, and are associated with better motivation or learning engagement. Both studies demonstrate that animated videos effectively capture students' attention, provide an enjoyable learning environment, and correlate with increased motivation and engagement in learning. However, in this research, motivation and engagement were not explicitly assessed. Therefore, the statement that learning autonomy is enhanced by increased motivation should be seen as a hypothesis possibly supported by existing literature, rather than as a definitive conclusion drawn from the findings of this research.

One theory consistent with the results is that animated videos facilitate a more organized approach to teaching, enhancing students' understanding of the subject and yielding better responses on the learning autonomy questionnaire. These findings are consistent with the research conducted by Dewanti & Putra (2022), which shows that animated videos in education are considered appropriate and effective in facilitating independent learning. Dian et al. (2024) explain that animated videos help clarify complex ideas thru event visualizations, process demonstrations, and examples that can be understood by elementary school students. In the natural and social sciences framework, this media explains why students in the experimental class show higher scores in learning independence: not only due to increased motivation in a measurable psychological context but also because the material becomes more accessible and understandable throughout the learning process.

Combined effects (MANOVA) and its implications

Simultaneous analysis of the two variables thru the MANOVA test shows that the difference between the experimental group and the control group remains significant. However, the Box's test showed a significance value of 0.007, indicating that the assumption of homogeneity of covariance matrices between groups is not fully met. Therefore, a more appropriate interpretation relates to Pillai's Trace, which is comparatively more robust in such conditions. The Pillai's Trace value of 0.769, with $F = 78.208$ and a significance level of 0.000, indicates a substantial relationship between the class and the combination of understanding and independent learning variables of the students. The differences in treatment in this research are clearly evident in each variable, both individually and collectively.

The use of animated videos in natural and social sciences learning, as shown by this research, seems to enhance conceptual understanding and is associated with an increase in scores in learning independence. These findings align with the constructivist philosophy, which

emphasizes student participation, autonomy in learning, and social interaction in the educational process (Wibowo et al., 2025). However, the results of the manova do not inherently imply that an increase in understanding leads to an increase in independence, or vice versa. These findings are better understood as both developing concurrently in the same care setting. Therefore, the discourse must remain cautious to avoid exceeding the current empirical data.

Constraints and prospective efforts

Although the research findings show substantial variation, extrapolation of these results should be done with caution. This research was conducted in a single educational environment, namely Kraton 2 Elementary School in Bangkalan, so the effectiveness of the identified animated videos here may not universally apply to all schools, educational levels, disciplines, or diverse student demographics. Additionally, other risks to validity should also be discussed in the conversation. Initially, there is the potential for a teacher effect, related to variations in enthusiasm, pedagogical ability, or instructor interaction with the class that might impact the outcomes. Second, a novelty effect may occur, as animated video media might appear fresh and engaging to students, indicating that the positive reaction may not solely stem from the educational quality of the media itself. Third, the possibility of cross-class contamination must be acknowledged, especially if students from the experimental and control groups exchange information outside the educational environment. Fourth, fidelity in implementation is crucial to consider, as the effectiveness of the media is greatly influenced by the consistency of educators' use of animated videos throughout the learning process. In addition, various factors such as variations in exposure duration, evaluative teaching approaches, or instructors' focus on certain elements during the learning process can also affect the outcomes. Therefore, further research should evaluate the impact of animated videos on understanding and self-directed learning, while also assessing relevant mediating or explanatory variables, including learning motivation, cognitive load, student engagement, and self-regulation. Further studies should include a larger sample, diverse educational institutions, and stricter implementation oversight to enhance causal interpretation. The findings regarding the use of animated videos not only show variations in learning outcomes but also effectively explain the underlying mechanisms.

CONCLUSION

Research findings indicate that the use of animated video learning media in the natural and social sciences class for 4th-grade students at Kraton 2 Elementary School in Bangkalan correlates with an increase in conceptual understanding and learning independence among students. The experimental class's understanding score increased from 39.12 to 72.00, while the control class's score rose from 28.56 to 44.64. In the domain of learning independence, the experimental group's score increased from 28.12 to 57.84, while the control group's score rose from 28.36 to 31.12. The results of the independent sample t-test showed a significance value of 0.000, which is less than 0.05, for both variables. Additionally, the MANOVA test using Pillai's Trace also revealed a significance of 0.000, concluding that there is a significant difference between students who learn with animated videos and those who learn without such media. These findings are supported by a large effect size, indicating that the observed changes are statistically significant and practically meaningful within the scope of this research.

These results indicate that educators can use animated videos as an additional tool to explain abstract natural and social sciences concepts in a more tangible, engaging, and easily understandable way for students. However, its implementation requires careful planning, ensuring that the videos align with learning objectives, student demographics, appropriate duration, and are integrated with discussions, Q&A sessions, and independent assignments to prevent passive viewing by students. The implementation of this media requires basic infrastructure support, including playback devices, LCD/projectors, adequate audio, energy,

and the readiness of educators to continuously select and use the media. However, these findings should be interpreted with caution, as the research was conducted in a single school and focused on one subject, thus limiting the generalization of the results. Therefore, further research is recommended to include more diverse educational environments, different subjects, and additional factors such as motivation, engagement, and self-regulation to explain the mechanisms by which animated videos have their impact in greater depth.

RECOMMENDATION

Future research is recommended to develop more innovative and interactive animated video learning media that are adapted to students’ characteristics and learning needs. The focus should be directed toward examining the long-term impact of animated video media on students’ learning outcomes, motivation, and self-regulated learning skills. Moreover, teacher training and institutional support are essential to ensure effective integration of digital media in classroom practices. Challenges such as limited technological facilities, teachers’ digital competencies, and students’ access to learning devices should also be addressed in future studies and educational implementation.

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AUTHOR CONTRIBUTIONS STATEMENT

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Victor Maruli Old L. Tobing		✓		✓	✓			✓		✓	✓	✓		✓
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CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

INFORMED CONSENT

We have obtained informed consent from all individuals included in this study.

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