

The Effect of The Discovery Learning Model Assisted By Animated Video Media On Students' Cognitive Learning Outcomes Regarding Environmental Pollution

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Abstract.

This study aimed to determine the effect of the Discovery Learning model assisted by animated video media on students' cognitive learning outcomes regarding environmental pollution. The study employed a quantitative approach with a quasi-experimental method using a Nonequivalent Control Group Design. The research was conducted at SMA Negeri 2 Mutiara, with a population of 115 students. Two classes were selected based on the results of a placement test consisting of 30 multiple-choice questions. The experimental class received instruction using the Discovery Learning model assisted by animated video media, whereas the control class received the Discovery Learning model without animated video assistance. Data were collected through pretests and posttests measuring students' cognitive learning outcomes. Before being administered, the test instrument was subjected to validity and reliability testing. Data analysis involved normality and homogeneity tests as prerequisite analyses, followed by analysis of covariance (ANCOVA) using SPSS. The results showed that the mean cognitive learning outcome in the experimental class increased from 41.00 in the pretest to 81.40 in the posttest, representing an increase of 50%. Meanwhile, the control class increased from 39.82 to 60.86, representing an increase of 34.57%. The ANCOVA results indicated a significant effect of class treatment on students' cognitive learning outcomes ($F = 223.908$; $\text{Sig.} = 0.000 < 0.05$). Furthermore, the adjusted mean score of the experimental class (81.493) was higher than that of the control class (60.782), and the LSD test showed a significant difference between the two groups. Therefore, the Discovery Learning model assisted by animated video media was more effective than Discovery Learning in improving students' cognitive learning outcomes on environmental pollution.

Keywords: *Discovery Learning, animated video, cognitive learning outcomes, environmental pollution and Biology learning.*

I. INTRODUCTION

Biology education aims not only for the mastery of facts and concepts but also for developing students' ability to understand biological phenomena scientifically and relate them to issues in their immediate environment. Environmental pollution is a biology topic closely linked to daily life. It encompasses various concepts, including types of pollution, sources of pollutants, the mechanisms of pollution, its impact on ecosystems, and mitigation strategies. Consequently, teaching this topic requires learning experiences that enable students to observe phenomena, identify problems, establish cause-and-effect relationships, and devise solutions based on biological concepts. Research indicates that pollution issues serve as a relevant context for fostering students' critical thinking and problem-solving skills (Jariah et al., 2024; Sigit et al., 2024). Nevertheless, teaching environmental pollution presents challenges, particularly in ensuring students grasp the concepts meaningfully. Due to the nature of the subject matter which involves complex processes and cause and effect relationships some concepts are difficult to comprehend through verbal explanations or textbooks.

Students require more concrete representations of pollution phenomena to bridge the gap between the concepts they study and the environmental conditions they encounter. Dewi and Amalia (2022) highlight the need for real-world examples and instructional media that connect these concepts to actual environmental phenomena. Similarly, efforts to develop instructional media for this topic underscore the demand for more diverse and contextual learning resources (Erawati & Susanti, 2022; Lesmanawati et al., 2024).

This issue is increasingly significant because cognitive learning outcomes serve as a key indicator of instructional success. These outcomes reflect a learner's ability to acquire, comprehend, apply, analyze, and utilize the knowledge they have studied. Instruction that remains teacher-centered and relies heavily on the transmission of information may limit opportunities for students to engage actively in the process of constructing knowledge. Therefore, there is a need for an instructional model that positions students as active participants in their own learning, providing them with opportunities to acquire knowledge through activities such as discovery, information processing, and drawing conclusions. One model well-suited to these requirements is Discovery Learning. This model enables students to grasp concepts through a process of discovery. Rather than merely receiving information from the teacher, students are encouraged to identify problems, gather and process information, verify their findings, and formulate conclusions. These characteristics make Discovery Learning particularly appropriate for biology instruction, as biological concepts can be learned through the observation of phenomena and processes of inquiry. Research by Jamallika et al. (2024) demonstrates that video supported Discovery Learning can enhance students' conceptual mastery and scientific literacy. Other studies further indicate that Discovery Learning positively influences critical thinking skills and learning outcomes in biology education (Agustini et al., 2025; Fatari et al., 2025).

However, the independent application of Discovery Learning may not be optimal if students struggle to form a concrete mental image of the phenomenon being investigated. In such cases, instructional media can serve as a stimulus, helping students observe and comprehend the phenomenon prior to engaging in the discovery process. Animated video is one such promising medium; it enables the presentation of objects, processes, changes, and inter-component relationships in a dynamic, visual format. Consequently, concepts that are difficult to observe directly can be visualized, making them easier for students to understand. Research by Caella and Yulianto (2024) demonstrates that using animated videos is more effective than conventional media for improving science learning outcomes. Similar results were reported by Safitri et al. (2026), who found that the use of animated videos led to significant differences in learning outcomes compared to conventional instruction. The use of animated videos also has the potential to enhance student attention and engagement during the learning process. A systematic review by Angelika et al. (2025) indicates that animated videos help visualize abstract scientific concepts and contribute positively to learning outcomes. These findings are reinforced by research from Inwanti et al., showing that animated videos can boost both student motivation and learning outcomes. Thus, animated videos are not merely a means of capturing attention; they serve as a tool for conceptual representation that supports students' cognitive processes.

Integrating animated videos with the Discovery Learning model is increasingly relevant because the two components complement each other. Discovery Learning provides a structured learning framework that encourages students to discover concepts, while animated videos offer visual representations of the phenomena being observed. This integration allows teachers to present environmental pollution phenomena via video during the stimulation phase, subsequently guiding students to identify problems, gather and process information, verify findings, and draw conclusions. Thus, animated videos serve as a stimulus for the discovery process rather than a substitute for the students' own cognitive engagement. Research by Anwar et al. (2023) specifically demonstrates that Discovery Learning supported by animated videos can enhance students' critical thinking skills in biology lessons. Meanwhile, Jamallika et al. (2024) show that video-assisted Discovery Learning influences students' conceptual mastery and scientific literacy. The context of environmental pollution also offers students the opportunity to connect biological knowledge with real-world environmental issues. Research by Cahyadini et al. indicates that environmental education linked to real-world problems can foster student engagement in understanding environmental issues. Furthermore, research by Shafira et al. (2026) demonstrates that instruction based on socio-scientific issues regarding environmental pollution can be used to develop higher-order thinking skills. These findings underscore the importance of delivering environmental pollution lessons that go beyond mere definition mastery, instead providing students with the experience of interpreting environmental phenomena based on the concepts they have learned.

While extensive research has been conducted on Discovery Learning and animated videos, previous studies have largely focused on their impact on critical thinking skills, scientific literacy, motivation, or general conceptual mastery. There is a need for further research specifically examining the effect of video-assisted Discovery Learning on cognitive learning outcomes regarding the topic of environmental pollution. Furthermore, whereas previous studies often compared video media against conventional instruction, this study compares two learning conditions that both employ Discovery Learning but differ in their use of animated videos. This design offers an opportunity to identify the specific contribution of animated video media to the effectiveness of Discovery Learning. Based on this context, this study aims to analyze the impact of the Discovery Learning model assisted by animated video media on students' cognitive learning outcomes regarding environmental pollution. The study's novelty lies in the integration of animated video media into the Discovery Learning model and the assessment of its impact on cognitive learning outcomes by comparing it with Discovery Learning without such video assistance. The findings are expected to provide empirical evidence regarding the effectiveness of animated videos as a supporting medium for Discovery Learning and to offer teachers an alternative approach for designing biology lessons that are more active, visual, and contextual, while also being oriented toward enhancing students' cognitive learning outcomes.

II. METHODS

This study employs a quantitative approach using a quasi-experimental design, specifically the Nonequivalent Control Group Design. Two classes were involved: an experimental class and a control class. The experimental class received instruction using the discovery learning model supported by animated video media, while the control class used the discovery learning model without such media. The study was conducted at SMA Negeri 2 Mutiara with a total population of 115 students. Regarding sampling, a placement test consisting of 30 multiple-choice questions was administered; classes with an average score below 50 were designated as the experimental group, while those with an average score above 50 served as the control group. Data collection involved the use of pre-tests and post-tests. Prior to the study, the test instruments underwent pilot testing to determine their validity and reliability. Data analysis began with a normality test using the Kolmogorov-Smirnov method to assess whether the data followed a normal distribution; data were considered normally distributed if the significance value exceeded 0.05. Subsequently, a homogeneity test was conducted as a prerequisite analysis. Once the prerequisites were met, hypothesis testing was performed using ANCOVA with the aid of SPSS software. This hypothesis testing aimed to determine whether the discovery learning model supported by animated video media had an effect on students' cognitive learning outcomes.

III. RESULT AND DISCUSSION

Research data regarding the mean scores and score percentages for cognitive learning outcomes from pretests and posttests show an increase. The increase in students' mean pretest and posttest scores for cognitive learning outcomes, achieved using the discovery learning model assisted by animated video media, is presented in Table 1.

Table 1. Mean Scores and Pretest-Posttest Score Percentages for Students' Cognitive Learning Outcomes

No	Model	Mean		Increase (%)	Note
		Pretest	Posttest		
1	Discovery learning model assisted by animated video media	41	81.4	50	Increased
2	Discovery learning model	39.82	60.86	34.57	Increased

Table 1 shows that the implementation of the discovery learning model assisted by animated video media improved students' cognitive learning outcomes in the experimental class, raising the average score from 41 on the pretest to 81.40 on the posttest. Meanwhile, the control class which also utilized the discovery learning model saw an increase from 39.82 to 60.86. However, the improvement in cognitive learning

outcomes in the experimental class was greater, reaching 50%, compared to 34.57% in the control class. The results of the ANCOVA test regarding the difference in students' cognitive learning outcomes between discovery learning assisted by animated video media and the standard discovery learning model are presented in Table

Table 2. ANCOVA Results for Students' Cognitive Learning Outcomes

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	5705.658 ^a	2	2.852.829	111.967	.000
Intercept	6.899.637	1	6.899.637	270.796	.000
X Cognitive Learning Outcomes	42.514	1	42.514	1.669	.202
Class	5.704.983	1	5.704.983	223.908	.000
Error	1.299.434	51	25.479		
Total	274.412.500	54			
Corrected Total	7.005.093	53			

Based on the data in Table 2, the p-value (0.000) is less than α (0.05), with significance levels of 0.000 and 0.000. This indicates that the null hypothesis (H_0) stating that there is no effect of the discovery learning model assisted by animation media on students' cognitive learning outcomes is rejected, while the research hypothesis stating that there is an effect of the discovery learning model assisted by animated video media on students' cognitive learning outcomes is accepted. Thus, it can be concluded that the discovery learning model assisted by animated video media influences students' cognitive learning outcomes. The results of further analysis regarding the effect of the discovery learning model assisted by animated video media on students' cognitive learning outcomes are presented in Table 3.

Table 3. Results of the Follow-up Test on the Effect of the Discovery Learning Model Assisted by Animated Video Media on Students' Cognitive Learning Outcomes

No	Model	X Cognitive Learning Outcomes	Y Cognitive Learning Outcomes	Difference	Cognitive Learning Outcomes	Notation LSD
1	Discovery learning model assisted by animated video media	41.000	81.400	40.400	81.493	a
2	Discovery learning model	39.827	60.862	21.035	60.782	b

The results of the Least Significant Difference (LSD) post-hoc test presented in Table 3 indicate a significant difference between the discovery learning model supported by animated video media and the discovery learning model used without such media support. The research findings demonstrate that the application of the discovery learning model supported by animated video media has a significant impact on students' cognitive learning outcomes. This is evidenced by the fact that the mean cognitive learning score for the discovery learning model supported by animated video media differed significantly from that of the discovery learning model used without media support. This difference in cognitive learning outcomes arises because the discovery learning model provides students with the opportunity to discover concepts independently through a process of observation, problem identification, data collection, information processing, and drawing conclusions.

The findings of this study demonstrate that the implementation of the Discovery Learning model assisted by animated video media had a positive effect on students' cognitive learning outcomes regarding environmental pollution. The improvement was evident from the increase in the mean score of the experimental class from 41.00 in the pretest to 81.40 in the posttest. Although the control class, which implemented Discovery Learning without animated video media, also showed improvement from 39.82 to 60.86, the increase in the experimental class was considerably greater. The difference in the corrected mean scores was also substantial, with 81.493 for the experimental class and 60.782 for the control class. These findings indicate that the integration of animated video media into Discovery Learning provided an

additional instructional advantage beyond the use of the learning model. The effectiveness of Discovery Learning in improving learning outcomes can be explained by its emphasis on students' active involvement in constructing knowledge. Discovery Learning encourages students to identify problems, collect and process information, formulate relationships among concepts, and draw conclusions based on the evidence they obtain. Such learning activities are particularly relevant to environmental pollution because the topic contains concepts that require students to connect causes, processes, impacts, and solutions to environmental problems. Previous research has shown that Discovery Learning can improve students' learning outcomes because it provides opportunities for learners to actively discover concepts rather than merely receive information from teachers. Prasetyo and Lenggono (2024), for example, reported an increase in Biology learning outcomes following the implementation of an integrated Discovery Learning model. Similarly, Satriani et al. (2021) found that Discovery Learning supported by the environment as a learning resource significantly influenced students' learning outcomes.

These findings support the present study by demonstrating that the active and investigative characteristics of Discovery Learning are conducive to improving students' cognitive achievement. The present findings further indicate that the effectiveness of Discovery Learning can be enhanced when the model is supported by appropriate visual media. In the experimental class, animated video media provided students with visual representations of environmental pollution phenomena that may be difficult to observe or explain adequately through verbal descriptions. Animated videos can illustrate the sources of pollutants, the movement and accumulation of pollutants in environmental components, changes in environmental quality, and the consequences of pollution for organisms and ecosystems. Consequently, students can observe relationships between concepts in a more concrete and sequential manner. This interpretation is consistent with Caella and Yulianto (2024), who reported that animated video media could increase students' interest and learning outcomes in science learning. Similarly, Supriyani et al. (2021) found that animated learning videos contributed to improved science learning outcomes among elementary school students.

The combination of Discovery Learning and animated video media is particularly important because the two components perform complementary functions. Discovery Learning provides the pedagogical structure through which students actively investigate and construct knowledge, whereas animated video provides a visual and auditory stimulus that facilitates the presentation of phenomena. In other words, the animated video does not replace the discovery process but serves as a stimulus and source of information within that process. This combination allows students to observe phenomena, formulate questions, identify relevant information, discuss possible explanations, and construct conclusions based on the information obtained. Pratiwi et al. (2024) provide particularly relevant evidence because their study specifically developed an animated video based on Discovery Learning and found that the resulting media was effective in improving students' knowledge competencies. Their findings strengthen the argument that animated video and Discovery Learning can be integrated into a coherent instructional design rather than being treated as separate instructional components.

The significant result of the ANCOVA analysis further confirms the effectiveness of the treatment. The analysis produced a significance value of 0.000 for the class variable, which is lower than $\alpha = 0.05$. Therefore, the null hypothesis stating that there is no difference in cognitive learning outcomes between the two learning conditions is rejected. More importantly, the significant class effect was obtained after the initial cognitive learning outcome was included as a covariate. This means that the difference between the experimental and control classes cannot simply be attributed to differences in students' initial achievement. The adjusted means reinforce this conclusion: the experimental class achieved a corrected mean of 81.493, whereas the control class achieved 60.782. The LSD follow-up test placed the two classes in different statistical groups, indicated by notation "a" and "b," confirming that the adjusted mean cognitive outcomes differed significantly between the two treatments. The magnitude of the difference between the corrected means also provides an important interpretation of the findings. The experimental class exceeded the control class by approximately 20.71 points after adjustment. This difference is educationally meaningful because both classes used Discovery Learning, while the main distinguishing feature was the integration of animated

video media. Thus, the findings suggest that animated video contributed additional value to the Discovery Learning process.

This interpretation is consistent with Tamaela et al. (2024), who found that Discovery Learning assisted by video significantly affected students' analytical thinking abilities. Although their dependent variable was analytical thinking rather than cognitive learning outcomes, their findings indicate that video-supported Discovery Learning can strengthen higher-level cognitive processes. Similarly, Mumtazah et al. (2024) reported that Discovery Learning integrated with socio-scientific issues significantly influenced students' cognitive learning outcomes. Together, these studies suggest that the effectiveness of Discovery Learning can be strengthened when it is supported by instructional resources or contexts that stimulate students' cognitive engagement. The role of animated video can also be understood from the perspective of students' cognitive processing. Environmental pollution involves multiple interconnected processes, including pollutant sources, environmental pathways, ecosystem responses, and human impacts. When these processes are presented only through textbooks or verbal explanations, students may experience difficulty forming accurate mental representations. Animated video can reduce this difficulty by presenting information through coordinated visual and auditory channels. Students can observe changes and processes dynamically, making abstract relationships more accessible. Sariwedani et al. (2025) similarly reported that interactive learning video media had a significant influence on science learning outcomes. Their findings emphasize that video-based learning media can help address difficulties in presenting science concepts and can contribute to improved student achievement.

The findings are also consistent with research specifically examining animated video media in science and Biology education. Aulia et al. (2025) reported that the use of animated videos improved science learning outcomes among junior high school students. The study demonstrated that animated video media could provide an alternative to conventional learning resources and support students' understanding of science content. In addition, the use of animated video in Biology-related learning has been reported to support students' learning processes by providing more engaging representations of subject matter. Sobariyah et al. (2025), although focusing on digital literacy rather than cognitive learning outcomes, found that Discovery Learning assisted by digital media produced significant differences between the experimental and control groups. This supports the broader argument that integrating technology-supported resources with Discovery Learning can create a more active and meaningful learning environment.

The improvement observed in the experimental class may also be associated with increased student attention and engagement during learning. Animated video contains visual movement, narration, illustrations, and contextual examples that can make learning more attractive than static instructional materials. Increased attention can provide students with greater opportunities to process and retain information presented during the discovery process. However, the effectiveness of the media should not be interpreted merely in terms of entertainment. Its educational value depends on whether the animation is directly connected to the learning objectives, contains scientifically accurate information, and is integrated with activities that require students to analyze and interpret what they observe. Therefore, the present findings suggest that animated video is most beneficial when it functions as an integral component of the Discovery Learning syntax rather than as supplementary entertainment.

The findings have important implications for teaching environmental pollution. Environmental pollution is closely related to real-life problems, including air pollution, water pollution, soil pollution, waste accumulation, and ecosystem degradation. Animated videos can present these phenomena in realistic and contextualized forms before students are guided to investigate their causes and consequences. Teachers can therefore use videos during the stimulation and problem-identification stages of Discovery Learning, followed by activities requiring students to collect information, classify pollutants, analyze environmental impacts, and formulate possible solutions. Such integration can shift learning from the memorization of definitions toward the development of meaningful cognitive understanding. Overall, the results indicate that Discovery Learning assisted by animated video media is more effective in improving students' cognitive learning outcomes than Discovery Learning implemented without animated video assistance. The improvement in the experimental class, the significant ANCOVA result, and the significant difference in

adjusted means collectively provide evidence that the integration of animated video adds instructional value to Discovery Learning. The findings are consistent with recent research showing that Discovery Learning can improve learning outcomes and that video-based instructional media can facilitate science learning. Therefore, animated video-assisted Discovery Learning can be considered a promising instructional strategy for environmental pollution topics, particularly when the video content is contextual, scientifically accurate, visually clear, and systematically integrated into the stages of discovery learning.

IV. CONCLUSION

The discovery learning model assisted by animation media had a significant effect on student learning outcomes regarding the topic of environmental pollution at SMA Negeri 2 Mutiara, with a p-value of 0.000 (less than $\alpha = 0.05$). Results from the Least Significant Difference (LSD) post-hoc test indicated a significant difference between the experimental class which used the discovery learning model assisted by animation media and the control class, which used the discovery learning model.

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