

The Effect of Three-Dimensional (3D) Animation Learning Media on Students' Learning Outcomes in Optics at MTsN 2 Kediri

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ABSTRACT

Optics instruction at the secondary school level continues to face challenges in attracting students' attention, although visual media such as videos have been used to facilitate the understanding of abstract concepts. However, the use of conventional videos at MTsN 2 Kediri has not produced optimal outcomes, as indicated by an average test score of 69, which remains below the Minimum Mastery Criterion (KKM) of 75. In response to this condition, the present study aimed to examine the effect of using three-dimensional (3D) animation learning media on students' learning outcomes in optics. A quasi-experimental method with purposive sampling was employed, involving two classes designated as the experimental and control groups. The research instruments comprised a multiple-choice test and a student response questionnaire. The findings showed that the experimental group achieved an average score of 76.7, whereas the control group obtained 53.9. An independent-samples t-test yielded a significance value of .000 ($p < .05$), demonstrating that the use of 3D animation media had a significant effect on students' learning outcomes. In addition, students' responses to the media reached 83.15%, indicating a high level of acceptance. Thus, three-dimensional (3D) animation learning media were effective in improving students' learning outcomes in optics at MTsN 2 Kediri.

Keywords: *Learning Media, Learning Outcomes, Three-Dimensional Animation (3D)***Article History:**Received 19th January 2026Accepted 15th October 2026Published 21st October 2026

INTRODUCTION

Physics is a branch of natural science that examines natural phenomena and the principles underlying events in the surrounding environment. Physics instruction aims to develop students' scientific thinking, conceptual understanding, and ability to apply scientific knowledge in everyday life. However, physics learning can be challenging because some concepts involve abstract processes that are difficult to observe directly. When instruction relies heavily on memorizing formulas and static visual representations, students may have difficulty developing a meaningful understanding of these concepts. Multimedia learning research suggests that appropriately designed visual and verbal representations can help learners process complex information and construct a more coherent understanding (Abdulrahman et al., 2020; Mayer & Moreno, 2002). Furthermore, animation can be beneficial when it represents dynamic processes that static images cannot adequately convey, although its effectiveness depends on how the material is designed and presented (Höffler & Leutner, 2007; Mayer, 2021).

Observations at MTsN 2 Kediri indicated that physics instruction was supported by adequate facilities, including a laboratory and LCD projectors. Teachers had also used videos as learning media; however, most of these videos were relatively static and did not sufficiently attract students' attention. Consequently, student engagement remained low. This condition was also reflected in learning outcomes: 56.5% of students did not meet the Minimum Mastery Criterion (KKM), and the average score on the topic of light was 69. These classroom

observations suggest a need for learning media that can present physical phenomena more clearly and encourage active student engagement.

One potential approach is the use of three-dimensional (3D) animation as a learning medium. Animation can illustrate the movement of light rays and represent phenomena such as reflection and refraction in a visual and dynamic format. Research on animation-based physics instruction has investigated its potential to support students' understanding of physical concepts and learning outcomes (Suhandi & Nur, 2010; Wildani et al., 2021). In addition, research on audio-visual animation has examined its contribution to students' conceptual understanding, while a quasi-experimental study by Nurnaifah et al. (2024) reported differences in physics learning outcomes between students taught using animation media and those receiving conventional instruction. Research on physics simulations has also demonstrated the educational value of interactive visual representations for supporting students' exploration of physical phenomena (Perkins et al., 2006). These findings provide a rationale for investigating animation-based instruction, although the effectiveness of a particular medium should be established in its specific instructional context.

Despite the growing use of animation in physics education, the present study focuses specifically on the use of 3D animation for the topic of light at MTsN 2 Kediri. The study addresses the need to evaluate whether this medium can improve students' learning outcomes in the local classroom context and how students respond to its use. Therefore, this study aimed to determine the effect of 3D animation learning media on students' learning outcomes and examine students' responses to its implementation in learning the topic of light at MTsN 2 Kediri.

METHOD

Research Design and Participants

This study employed a quantitative approach and a quasi-experimental method using a non-equivalent pretest-posttest control group design. This design was selected because the participants could not be fully randomized; therefore, existing classes were used as the study groups. Quasi-experimental designs are appropriate for evaluating interventions in educational settings where random assignment may not be feasible (Shadish et al., 2002). The study was conducted in April 2025 at MTsN 2 Kediri, Kediri Regency, East Java. The study population comprised all eighth-grade students in the 2024/2025 academic year.

Samples were selected using purposive sampling, in which participants are chosen based on specific considerations relevant to the research objectives (Creswell & Creswell, 2018). The classes were selected upon the recommendation of the science teacher, taking into account their relatively similar characteristics, including academic ability, number of students, content not yet studied, and instruction by the same teacher. Based on these considerations, Class VIII-1, comprising 23 students, was selected as the control group, whereas Class VIII-2, comprising 27 students, was selected as the experimental group. Before the intervention, both groups completed a pretest to assess their initial ability. The experimental group then received instruction in optics using three-dimensional (3D) animation media, whereas the control group received instruction using non-animated media in accordance with the school's usual instructional practice. After all content had been delivered, both groups completed a posttest to assess learning outcomes following the intervention. In addition, a response questionnaire was administered only to the experimental group to obtain students' views regarding the use of 3D animation media.

Research Instruments

The research instruments consisted of a learning outcome test and a student response questionnaire. The learning outcome test comprised 10 multiple-choice items developed on the basis of learning achievement indicators for optics across the C1–C6 cognitive domains. The same items were used for the pretest and posttest to facilitate comparison of students'

scores before and after the intervention. However, using the same items may introduce a practice effect that should be considered when interpreting the results.

The student response questionnaire used a four-point Likert scale: Strongly Agree (4), Agree (3), Disagree (2), and Strongly Disagree (1). The questionnaire measured students' perceptions of the media's appearance, ease of use, clarity of content, attractiveness, and benefits in the learning process. The percentage of student responses was interpreted according to the criteria proposed by [Amruddin et al. \(2022\)](#): 81–100% (strongly agree), 61–80% (agree), 41–60% (disagree), and 40% or below (strongly disagree).

Before being used in the study, all instruments underwent a validation process. Content validity was assessed by a media expert and a physics subject-matter expert to evaluate the appropriateness of the content, construction, language, and alignment of the instruments with the learning objectives. Expert judgment is one approach to evaluating the relevance and representativeness of instrument content ([Lynn, 1986](#)). The test instrument was subsequently piloted with students outside the study sample. The empirical validity of each item was analyzed using Pearson's product-moment correlation; an item was considered valid when the calculated correlation coefficient exceeded the critical value at a 5% significance level. The reliability of the test instrument was analyzed using Cronbach's alpha, an index of internal consistency based on relationships among test items ([Cronbach, 1951](#)). A coefficient of .70 or higher was used as the criterion for acceptable reliability. The reliability of the student response questionnaire was likewise calculated using Cronbach's alpha, with a coefficient of .60 or higher treated as adequate for this study.

Data Analysis

Data were analyzed using IBM SPSS Statistics version 26. First, descriptive statistics were calculated to obtain the mean, maximum, minimum, and standard deviation of the pretest and posttest scores for each group. Assumption testing was then performed, including the Shapiro–Wilk normality test and Levene's test of homogeneity of variance. The Shapiro–Wilk test evaluates whether a sample is consistent with a normally distributed population ([Shapiro & Wilk, 1965](#)). Data were considered normally distributed when the significance value exceeded .05 and homogeneous when Levene's test significance value exceeded .05.

The hypothesis was tested using an independent-samples t-test at the 5% significance level to determine whether learning outcomes differed between the experimental and control groups. The equal-variance or unequal-variance result was selected based on the outcome of Levene's test. The null hypothesis was rejected when the two-tailed significance value was below .05; otherwise, the null hypothesis was not rejected. A statistically significant difference between groups was interpreted as evidence of a difference in their posttest performance, rather than definitive proof of a causal effect, because the groups were not randomly assigned and their baseline equivalence must be considered.

Student questionnaire data were analyzed using the percentage formula:

$$p = \frac{f}{N} \times 100\%$$

where (P) represents the percentage, (f) represents the observed response frequency or score, and (N) represents the maximum possible frequency or score, as appropriate to the calculation. The resulting percentages were interpreted using the predetermined categories to describe students' responses to the 3D animation learning media.

FINDINGS AND DISCUSSION

Table 1. Normality Test for the Control and Experimental Groups

Tests of Normality			
		Kolmogorov-Smirnov ^a	Shapiro-Wilk
Group	Statistic df	Statistic df	Sig.

Experimental Pretest	.194	27	.010	.936	27	.097
Experimental Posttest	.177	27	.029	.941	27	.131
Control Pretest	.185	23	.041	.926	23	.089
Control Posttest	.173	23	.073	.924	23	.080

a. Lilliefors Significance Correction

Based on the normality-test results presented in Table 1, the experimental group's pretest and posttest yielded significance values of .097 and .131, respectively, both greater than .05. The control group's pretest and posttest yielded significance values of .089 and .080, respectively, also greater than .05. Therefore, the data were normally distributed because all significance values exceeded .05.

Table 2. Homogeneity Test for the Control and Experimental Groups

Levene		df1	df2	Sig.	
Statistic					
Students'	Based on Mean	.495	1	48	.485
Learning	Based on Median	.179	1	48	.674
Outcomes	Based on Median and with Adjusted df			1 47.23 1	.674
	Based on Trimmed Mean	.491	1	48	.487

The homogeneity test was conducted to determine whether the variances of the *posttest* data from the experimental group and the *posttest* data from the control group were homogeneous. Based on Table 3, the homogeneity-test results showed that the Sig. value for *Based on Mean* was .485 > .05. Therefore, the variances were equal or homogeneous. Accordingly, one of the assumptions (although not an absolute requirement) for the *independent-samples t-test* was satisfied.

Table 3. Hypothesis Test for the Control and Experimental Groups

Independent Samples Test										
Levene's Test for Equality of Variances										
Variances					t-test for Equality of Means					
					Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference		
								Lower	Upper	
Test Score	Equal Variances Assumed	.495	.485	5.873	48	.000	22.754	3.874	14.964	30.543
Equal Variances not assumed					5.826	44.9	.000	22.754	3.906	14.886
					05					30.621

Hypothesis testing was conducted using an *independent-samples t-test*. This test was used to examine differences in students' learning outcomes between the control and experimental groups. Based on Table 3, the hypothesis-test results showed that the Sig. (2-tailed) value under *Equal Variances Assumed* was $.000 < .05$. Because the significance value was below $.05$, H_a was accepted. Thus, a statistically significant difference was found, indicating an effect of three-dimensional (3D) animation learning media on the experimental group's learning outcomes for the topic of light.

Based on the statistical analysis conducted using *IBM SPSS Statistics* version 26.0, the hypothesis was tested using an *independent-samples t-test*. The Sig. (2-tailed) value under *Equal Variances Assumed* was $.000 < .05$. Because the significance value was below $.05$, H_a was accepted. It can therefore be concluded that the use of three-dimensional (3D) animation learning media affected students' learning outcomes for the topic of light at MTsN 2 Kediri.

NAME	ITEMS										Σ	%
	1	2	3	4	5	6	7	8	9	10		
	4	4	4	3	4	3	3	3	3	3	34	85
	3	3	4	3	4	3	3	3	2	3	31	77.5
	4	3	4	3	4	3	3	3	3	4	34	85
	3	3	4	4	4	3	3	4	3	4	35	87.5
	4	4	4	3	4	3	4	3	3	4	36	90
	4	4	3	3	4	3	4	3	3	4	35	87.5
	4	3	3	3	4	3	3	3	3	3	32	80
H	3	2	2	2	1	2	3	1	2	2	20	50

Mean Percentage 83.15%

Figure 1 Student Response Questionnaire

Based on the student response questionnaire presented in Table 4, the experimental group's responses to the use of three-dimensional (3D) animation learning media achieved a mean percentage of 83.15%. This result indicates that the students were enthusiastic and actively engaged in the learning process when using three-dimensional (3D) animation learning media.

The findings of this study are consistent with those reported by Nurhayani et al. (2015). Their analysis of covariance of the *Pretest* and *Posttest* scores obtained by the experimental and control groups produced an F-residual value of 9.925, with numerator and denominator

degrees of freedom of 17 and 1, respectively. Comparison with the F-table value reported in the appendix showed that the calculated F-residual exceeded the F-table value at the 5% significance level ($9.925 > 4.45$). This finding indicates that animation media affected students' biology learning outcomes for the concept of the human circulatory system; therefore, the research hypothesis was accepted.

CONCLUSIONS

Based on the findings, it can be concluded that the use of three-dimensional (3D) animation learning media for the topic of light at MTsN 2 Kediri had a significant effect on students' learning outcomes. This result was indicated by the experimental group's mean posttest score of 76.7, which was higher than the control group's score of 53.9. Statistical testing using an *independent-samples t-test* yielded a significance value of .000 ($p < .05$); therefore, the alternative hypothesis (H_a) was accepted. Thus, three-dimensional (3D) animation media were shown to be effective in improving students' learning outcomes. In addition, students' responses to the use of three-dimensional (3D) animation learning media were categorized as highly positive, with a percentage of 83.15%. This finding indicates that students were more active, enthusiastic, and interested in participating in the learning process. Therefore, three-dimensional (3D) animation media can serve as an effective and innovative alternative for physics instruction, particularly for abstract subject matter. The application of these media positively affected the learning process by helping students visualize concepts that are difficult to observe directly, increasing engagement and learning motivation, and creating a more interactive and student-centered learning environment. These findings also have practical implications for teachers, who may use technology-based media as an instructional innovation to improve the quality of both the learning process and learning outcomes, particularly for physics content that requires the visualization of abstract concepts.

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