

The Effect of Animated Instructional Media on Fourth-Grade Students' Mathematics Learning Outcomes in Roman Numerals

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ABSTRACT : This study examined the effect of animated instructional media on fourth-grade elementary school students' mathematics learning outcomes in Roman numerals. It employed a quantitative approach using a quasi-experimental method and a nonequivalent control group design. The study was conducted at SD Negeri 2 Konda with a sample of 55 students, comprising 29 students in the experimental class and 26 in the control class. Data were collected using achievement tests administered as a pretest and posttest. The data were analyzed through normality and homogeneity tests, hypothesis testing using an independent-samples t-test, and N-Gain analysis. The results showed that the experimental class achieved a mean posttest score of 84,79, which was higher than the control class mean of 73,34. Hypothesis testing yielded a significance value (Sig. 2-tailed) of 0,006 < 0,05; therefore, H_0 was rejected and H_1 was accepted. The N-Gain analysis further showed a mean improvement of 0,7533 in the experimental class, categorized as high, compared with 0,4446 in the control class, categorized as moderate. These findings indicate that animated instructional media had a significant effect on fourth-grade elementary school students' mathematics learning outcomes in Roman numerals.

Keywords: Animated Instructional Media, Learning Outcomes, Mathematics, Roman Numerals

INTRODUCTION

The development of information and communication technology has brought significant changes to education, particularly to instructional processes in elementary schools. The use of technology in instruction enables teachers to present content in more engaging and interactive ways that align with the characteristics of twenty-first-century learners. The integration of technology into education also encourages teachers to develop innovative instructional media that support meaningful learning. Ekadayanti et al. (2024) emphasize the importance of developing technology-based instructional media in elementary education as part of efforts to strengthen digital literacy and support the improvement of learning practices. One such application is animation-based instructional media, which integrates images, text, sound, and motion to enhance students' attention and learning motivation. Animated instructional media also help teachers make abstract concepts more concrete and, therefore, easier for students to understand.

Mathematics plays an important role in developing students' logical, critical, systematic, and creative thinking skills. However, at the elementary school level,

mathematics is still often perceived as difficult because many topics involve abstract concepts. Consequently, some students have difficulty understanding mathematical concepts, which contributes to low learning outcomes. Teachers therefore need to select instructional media and learning approaches that help students understand mathematics more easily and meaningfully. Previous research has shown that the selection of appropriate learning approaches can contribute to improving students' mathematics learning outcomes. Rustam et al. (2023) through a meta-analysis, found that the realistic mathematics approach had a positive effect on elementary students' learning outcomes. These findings reinforce the importance of using appropriate instructional strategies and media to support mathematics learning at the elementary school level.

Roman numerals are one mathematics topic that often poses difficulties for fourth-grade elementary students. Students must understand the numeral symbols as well as the addition and subtraction rules governing their notation. Unlike the Hindu-Arabic numeral system used in everyday life, Roman numerals follow specific conventions; consequently, students often make errors when reading, writing, or converting numbers. These difficulties indicate the need for instructional media that present Roman numeral concepts visually and make them easier to understand. The use of concrete and visual learning resources is particularly important because students at the elementary level require instructional representations that can connect abstract mathematical concepts with more easily observable forms.

Animated instructional media are considered effective in supporting mathematics instruction. Munir (2018) defines animated media as technology-based instructional media that use moving images to communicate information in a more engaging and interactive manner. Arsyad (2019) further explains that instructional media serve as tools that improve the effectiveness of content delivery and make learning more efficient. Through animated media, students not only view Roman numeral symbols but can also observe, step by step, how they are formed and how the notation rules are applied, thereby facilitating conceptual understanding. Apriadi (2021) states that animated video is an instructional medium capable of presenting content visually and dynamically, helping students understand abstract mathematical concepts. In this context, the use of visual instructional media is consistent with the findings of Ekadayanti (2022) who found that the use of instructional images could improve elementary students' learning outcomes. Although her study focused on social studies, the findings demonstrate the potential of visual media to support students' understanding and achievement in elementary education.

Previous studies have shown that the use of innovative learning models and instructional media can positively affect students' learning outcomes. Rustam et al.

(2023) reported through a meta-analysis that the Scramble learning model could improve elementary students' learning outcomes. Their findings indicate that instructional activities involving active student participation and meaningful learning experiences can contribute to improved academic achievement. Similarly, Rustam et al. (2023) found that the realistic mathematics approach positively influenced elementary students' learning outcomes. These findings provide further support for the importance of implementing innovative learning approaches in mathematics instruction. Furthermore, Ekadayanti et al. (2024) demonstrated the importance of technology-based learning media in elementary education through the development of mathematics and science learning media using Canva.

The study highlights the potential of digital media to support innovative learning practices and strengthen the use of technology in elementary education. Simanjuntak, Silaban, and Sitepu (2021) found that animated media improved elementary students' learning outcomes because the content was presented in a more engaging and interactive way. Ekadayanti et al. (2024) likewise concluded that animated media could enhance students' motivation, active participation, and comprehension during instruction. Muhibbah and Ibah (2021) reported that animated video in mathematics instruction significantly improved students' learning outcomes. Collectively, these studies indicate that innovative instructional media and learning approaches have the potential to improve instructional quality and students' learning outcomes, particularly in mathematics.

Nevertheless, research on the use of animated media for teaching Roman numerals in elementary schools remains relatively limited. Most previous studies have examined animated media in science, plane geometry, arithmetic operations, or other mathematical topics. Similarly, previous studies by Rustam and Ekadayanti have primarily focused on the effectiveness of learning models, realistic mathematics approaches, visual media, and digital media in improving learning outcomes and supporting elementary education. However, research specifically examining the effectiveness of animated instructional media in teaching Roman numerals remains limited. Accordingly, a research gap remains regarding the effectiveness of animated media in improving fourth-grade elementary students' mathematics learning outcomes in Roman numerals.

Classroom observations and interviews with the fourth-grade teacher at SD Negeri 2 Konda indicated that some students continued to experience difficulty understanding Roman numerals. Common errors included writing numeral symbols, applying subtraction rules, and converting Hindu-Arabic numerals to Roman numerals and vice versa. Daily assessment results also showed that approximately 40% of students had not met the Minimum Mastery Criterion. These conditions demonstrate

the need for instructional innovations that can improve students' understanding and learning outcomes. The use of technology-based media, as emphasized in previous studies on digital and visual learning media, may provide an alternative solution to these learning difficulties.

Based on these considerations, this study aimed to examine the effect of animated instructional media on fourth-grade elementary school students' mathematics learning outcomes in Roman numerals. The findings are expected to contribute to the development of technology-based instructional media and provide teachers with a reference for selecting effective media to improve mathematics learning outcomes in elementary schools.

METHODS

1. Research Approach and Design

This study employed a quantitative approach using a quasi-experimental method with a nonequivalent control group design. The study involved two groups: an experimental group that received mathematics instruction using animated instructional media and a control group that received conventional instruction. Both groups were administered a pretest before the instructional treatment and a posttest after the treatment to measure changes in students' mathematics learning outcomes.

Table 1. Nonequivalent Control Group Design

Group	Pretest	Treatment	Posttest
Experimental	O ₁	X	O ₂
Control	O ₃	–	O ₄

Note: O₁ = Pretest of the experimental group; O₂ = Posttest of the experimental group; O₃ = Pretest of the control group; O₄ = Posttest of the control group; X = Instruction using animated instructional media; – = Conventional instruction without animated instructional media.

The experimental group received instruction on Roman numerals using animated instructional media, while the control group received conventional instruction. The comparison of the pretest and posttest results between the two groups was used to determine the effect of the animated instructional media on students' mathematics learning outcomes.

2. Research Variables

This study involved an independent variable and a dependent variable. The independent variable was the use of animated instructional media in mathematics instruction on Roman numerals. The animated media were used as the treatment in the

experimental group to present Roman numeral concepts through visual, audio, and motion elements. The dependent variable was students' mathematics learning outcomes, which were measured through the results of the pretest and posttest.

3. Population and Sample

The population consisted of all 55 fourth-grade students at SD Negeri 2 Konda during the 2025/2026 academic year. The students were distributed into two classes. A saturated sampling technique was used because the entire population was included as the research sample. Class IV A, consisting of 29 students, served as the experimental group, while Class IV B, consisting of 26 students, served as the control group. Thus, the total number of participants in the study was 55 students.

4. Data Collection Instrument

Data were collected using a written mathematics achievement test consisting of 20 multiple-choice questions related to Roman numeral material. The test measured students' ability to recognize and write Roman numeral symbols, read Roman numerals, convert Hindu-Arabic numerals into Roman numerals and vice versa, and apply the rules of addition and subtraction in Roman numeral notation. The test was administered as a pretest and posttest to measure students' learning outcomes before and after the instructional treatment. The instrument was tested for validity and reliability before being used in the research.

5. Data Collection Procedure

The research was conducted through several stages. First, both groups were administered a pretest to determine their initial understanding of Roman numerals. Second, the experimental group received mathematics instruction using animated instructional media, whereas the control group received conventional instruction without animated media. The instruction was conducted based on the learning objectives and materials for fourth-grade mathematics. After the instructional process was completed, both groups were administered a posttest to measure their mathematics learning outcomes.

6. Data Analysis

The data were analyzed quantitatively using SPSS version 26. Descriptive statistics were used to determine the mean, standard deviation, minimum score, and maximum score of the pretest and posttest results. Before hypothesis testing, normality and homogeneity tests were conducted as prerequisite analyses. The Kolmogorov–Smirnov test was used to examine the normality of the data, while Levene's test was used to assess the homogeneity of variance.

After the prerequisite tests were completed, an independent-samples t-test was conducted to determine whether there was a significant difference in mathematics learning outcomes between the experimental and control groups. The hypothesis was

tested at a significance level of 0.05. A significance value below 0.05 indicated a statistically significant difference between the two groups. In addition, an N-Gain analysis was conducted to determine the level of improvement in students' learning outcomes from the pretest to the posttest. The results were categorized as low, moderate, or high based on the obtained N-Gain scores. The results of the statistical analysis were used to determine the effect of animated instructional media on fourth-grade students' mathematics learning outcomes in Roman numerals.

RESULT AND DISCUSSION

RESULT

The study was conducted at SD Negeri 2 Konda and involved 55 fourth-grade students distributed into an experimental group of 29 students and a control group of 26 students. The experimental group received mathematics instruction using animated instructional media, whereas the control group received conventional instruction. Data on students' learning outcomes were collected through pretests and posttests and analyzed using descriptive and inferential statistics with SPSS version 26.

A. Descriptive Statistics of Students' Learning Outcomes

Descriptive statistical analysis was conducted to provide an overview of students' mathematics learning outcomes before and after the instructional treatment. The analysis included the number of students, mean scores, and standard deviations for the pretest and posttest in both groups. The results are presented in Table 2.

Table 2. Descriptive Statistics of Students' Mathematics Learning Outcomes

Group	Test	N	Mean	Standard Deviation
Experimental	Pretest	29	40.90	13.06
	Posttest	29	84.79	12.43
Control	Pretest	26	53.62	14.89
	Posttest	26	73.35	16.97

The results indicate that the experimental group obtained a mean pretest score of 40.90, whereas the control group obtained a higher mean pretest score of 53.62. These results indicate that the experimental group had a lower initial level of achievement than the control group before the treatment. Following the instructional intervention, the experimental group's mean score increased substantially to 84.79,

representing a mean increase of 43.89 points. Meanwhile, the control group's mean score increased from 53.62 to 73.35, representing an increase of 19.73 points.

The greater increase in the experimental group suggests that instruction using animated instructional media was associated with a more substantial improvement in students' mathematics learning outcomes than conventional instruction. However, because the two groups had different initial mean scores, the interpretation of the treatment effect was further examined through inferential statistical analysis and normalized gain analysis.

1. Normality Test

A normality test was conducted to determine whether the data met the assumption of normal distribution required for parametric statistical analysis. The Kolmogorov–Smirnov test was used, with a significance value greater than 0.05 indicating that the data were normally distributed. The results are presented in Table 3.

Table 3. Kolmogorov–Smirnov Normality Test Results

Data		Statistic	df	Sig.	Interpretation
Experimental Group Pretest		0.141	29	0.146	Normal
Experimental Group Posttest		0.159	29	0.058	Normal
Control	Group Pretest	0.162	26	0.078	Normal
Control	Group Posttest	0.115	26	0.200	Normal

As shown in Table 3, the significance values for the experimental group's pretest and posttest were 0.146 and 0.058, respectively. Meanwhile, the control group's pretest and posttest produced significance values of 0.078 and 0.200, respectively. All significance values were greater than 0.05. Therefore, the data were normally distributed, indicating that the normality assumption for further parametric analysis was satisfied.

2. Homogeneity Test

A homogeneity test was conducted to determine whether the variances of the experimental and control groups were statistically equivalent. Levene's test was used, with a significance value greater than 0.05 indicating homogeneous variances. The results are presented in Table 4.

Table 4. Levene's Test of Homogeneity

Compariso n	Leven e Statistic	df 1	df 2	Sig.	Interpretati on
Experimental and Control Groups	3.739	1	53	0.059	Homogeneous

The results in Table 4 show a significance value of 0.059. Because the value was greater than 0.05, the null hypothesis of equal variances was not rejected. Thus, the variance of the learning outcome scores between the experimental and control groups was considered homogeneous. The data therefore satisfied the homogeneity assumption for parametric analysis.

3. Hypothesis Testing

Independent-Samples t-Test

An independent-samples t-test was conducted to determine whether a statistically significant difference existed between the learning outcomes of students who received instruction using animated instructional media and those who received conventional instruction. The results are presented in Table 5.

Table 5. Independent-Samples t-Test Results

Var	F	S	t	d	Si	Mea	Std.	De
iab		i		f	g.	n	Err	cis
le		g			(2	Diff	or	ion
		.			-	ere	Diff	
					ta	nce	ere	
					il		nce	
					e			
					d)			
Lea	3	0	-	5	0.	-11.	3.98	H ₀
rni	.	.	2.	3	0	446	334	rej

ng	7	0	8	0	95	ect
Out	3	5	7	6		ed
co	9	9	4			
me						
s						

The results show a significance value of 0.006, which is lower than the 0.05 significance level. Therefore, the null hypothesis was rejected, indicating a statistically significant difference in mathematics learning outcomes between the experimental and control groups. The results demonstrate that students who received instruction using animated instructional media achieved significantly different learning outcomes from students who received conventional instruction.

The negative mean difference reflects the direction of the group comparison used in the statistical output and does not indicate a negative effect of the treatment. Based on the descriptive statistics, the experimental group achieved a higher posttest mean score (84.79) than the control group (73.35). These findings indicate that animated instructional media had a significant effect on fourth-grade students' mathematics learning outcomes in the topic of Roman numerals.

B. Analysis of Learning Improvement Using N-Gain

N-Gain analysis was conducted to examine the magnitude of improvement in students' learning outcomes from the pretest to the posttest. The analysis was performed separately for the experimental and control groups.

Table 6. N-Gain Results for the Experimental Group

Description	Value
N	29
Mean N-Gain	0.7533
Standard Deviation	0.18137
Minimum	0.40
Maximum	1.00
Category	High

The experimental group obtained a mean N-Gain score of 0.7533, which was categorized as high. This result indicates that the improvement in students'

mathematics learning outcomes following instruction using animated instructional media was substantial. The N-Gain scores ranged from 0.40 to 1.00, indicating that all students in the experimental group experienced positive improvement between the pretest and posttest. The standard deviation of 0.18137 also indicates that the improvement was relatively consistent among the students.

Table 7. N-Gain Results for the Control Group

Description	Value
N	26
Mean N-Gain	0.4446
Standard Deviation	0.31266
Minimum	-0.17
Maximum	1.00
Category	Moderate

The control group obtained a mean N-Gain score of 0.4446, which was categorized as moderate. This finding indicates that conventional instruction also resulted in an improvement in students' mathematics learning outcomes, although the magnitude of improvement was lower than that observed in the experimental group. The N-Gain scores ranged from -0.17 to 1.00, indicating variation in individual student achievement. Some students experienced a decrease in scores, whereas others demonstrated substantial improvement.

Overall, the results show that the experimental group achieved a higher mean improvement than the control group. The experimental group's mean N-Gain score of 0.7533 was categorized as high, while the control group's mean N-Gain score of 0.4446 was categorized as moderate. These findings, together with the statistically significant result of the independent-samples t-test, indicate that animated instructional media were more effective than conventional instruction in improving fourth-grade students' mathematics learning outcomes in Roman numerals.

DISCUSSION

The findings showed that animated instructional media had a significant effect on fourth-grade students' mathematics learning outcomes in Roman numerals at SD Negeri 2 Konda. This effect was evident in the difference between the mean posttest score of 84,79 in the experimental class, which received instruction using animated media, and 73,34 in the control class, which received conventional instruction. In addition, the independent-samples t-test yielded a significance value of 0,006 (< 0,05),

indicating that animated media significantly affected students' mathematics learning outcomes. The N-Gain analysis further supported this finding: the experimental class obtained a mean score of 0,7533, categorized as high, whereas the control class obtained 0,4446, categorized as moderate. These results indicate that animated media improved students' learning outcomes more effectively than conventional instruction.

The improvement in learning outcomes suggests that animated media helped students understand the abstract concept of Roman numerals by presenting the material in a more concrete, engaging, and interactive format. Content delivered through moving images, text, color, and illustrations made it easier for students to understand Roman numeral notation rules and remember the relevant symbols. This finding is consistent with the Multimedia Learning Theory proposed by Mayer (2021), which explains that learning becomes more effective when information is presented through a combination of visual and verbal channels. Integrating multiple multimedia elements enables students to process information more effectively, thereby improving conceptual understanding and learning outcomes.

The findings are also supported by Munir (2018), who states that animated media are multimedia-based instructional resources capable of presenting information visually, dynamically, and interactively, thereby increasing students' attention, motivation, and understanding of the subject matter. Similarly, Arsyad (2019) explains that instructional media help teachers communicate content more effectively so that learning objectives can be achieved more optimally. In this study, animated media created a more active and enjoyable learning environment, enabling students to understand Roman numerals more readily than through conventional instruction alone.

The findings are consistent with several previous studies. Simanjuntak, Silaban, and Sitepu (2021) reported that animated media improved elementary students' learning outcomes by presenting content in a more engaging and comprehensible form. Wahyuni, Yanti, and Vazira (2024) likewise found that animated video positively affected fourth-grade students' mathematics learning outcomes by increasing their attention, motivation, and engagement during instruction. Wa Ode Eka Dayanti et al. (2024) also concluded that animated media enhanced students' active participation and understanding because abstract content could be visualized more concretely. These findings are further supported by Febriyanti, Sunarsih, and Muamar (2024) who found that animated media contributed to improvements in students' cognitive and affective learning outcomes. Thus, the present study strengthens the empirical evidence that animated media are effective instructional resources for improving mathematics learning outcomes in elementary schools.

This study offers novelty relative to previous research by specifically examining, through a quasi-experimental design, the effect of animated media on fourth-grade

elementary students' learning outcomes in Roman numerals. Previous studies have more frequently applied animated media to other mathematical topics or focused on developing instructional media. The present findings therefore provide empirical evidence that animated media are also effective for Roman numerals, a topic often considered difficult by students. The practical implication is that teachers can use animated media as an alternative instructional resource to improve the quality of mathematics instruction, particularly for abstract topics, thereby making learning more engaging and interactive and improving students' learning outcomes.

CONCLUSION

Based on the findings, animated instructional media had a significant effect on fourth-grade elementary school students' mathematics learning outcomes in Roman numerals. Students who received instruction using animated media achieved better learning outcomes than those who received conventional instruction. This conclusion is supported by the independent-samples t-test significance value of 0,006 ($< 0,05$) and the N-Gain results, which placed the experimental class's improvement in the high category. Animated media can therefore serve as an effective alternative instructional resource for helping students understand Roman numerals and improve their mathematics learning outcomes in elementary school.

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