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The impact of an articulate storyline on students' cognitive learning outcomes in mathematics at Muhammadiyah Mertosanan Elementary School

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ABSTRACT

The integration of digital media in elementary education is increasingly recognized as an effective approach to addressing students' learning difficulties. This study explores the impact of Articulate Storyline, an interactive multimedia platform, on the mathematics learning outcomes of third-grade students at Muhammadiyah Mertosanan Elementary School. The research was motivated by the challenge that many students scored below the minimum mastery criterion, highlighting the need for innovative instructional strategies to enhance comprehension and engagement in mathematics. A quasi-experimental design with pretest–posttest control groups was applied to compare the effectiveness of conventional teaching methods with those supported by Articulate Storyline. Data were collected primarily through pretests and posttests, supplemented by classroom observations. Statistical analyses confirmed that the experimental group, which learned with Articulate Storyline, achieved significantly higher posttest scores than the control group. Beyond numerical improvement, classroom observations also indicated increased student enthusiasm and active participation during the lessons supported by interactive media. The findings demonstrate that Articulate Storyline not only improves students' cognitive achievement in mathematics but also fosters a more engaging learning environment. This highlights its dual function as both a learning aid and a motivational tool, aligning with contemporary efforts to integrate technology into primary education. The novelty of this study lies in providing empirical evidence on the application of Articulate Storyline in the context of elementary mathematics learning in Indonesia, an area that remains underexplored. Practically, the results suggest that teachers can adopt interactive multimedia platforms as complementary tools to enrich mathematics instruction, improve student performance, and stimulate greater classroom engagement.

1. Introduction

Learning is essentially a structured process that involves the interaction of individuals, materials, and facilities to achieve predetermined objectives. While this process ideally ensures effectiveness and efficiency, many studies have shown that classroom learning often fails to reach optimal outcomes, particularly in mathematics at the elementary level. Recent evidence indicates that a significant number of students continue to perform below the minimum competency standards, reflecting not only cognitive difficulties but also low

engagement in the learning process. Conventional teaching methods, which rely heavily on lectures and limited instructional media, are often inadequate in fostering active participation and deep understanding. This situation highlights a research gap in the integration of innovative digital media, such as Articulate Storyline, which is designed to provide interactive and engaging learning experiences. Addressing this gap is crucial, as the effective use of technology-based media has the potential to improve student achievement and motivation, making it highly relevant for mathematics instruction in Indonesian elementary schools. Learning is also understood as the application of instructional principles to address challenges encountered during the teaching and learning process. It represents a structured integration of human resources, materials, facilities, tools, and methods that collectively influence the achievement of learning objectives [1]. Other research has indicated that mathematics learning specifically plays a crucial role in enhancing students' critical and analytical thinking skills [2]. Educators thus bear the responsibility of delivering mathematics instruction accurately and effectively so that students can comprehend the material thoroughly. Findings from earlier studies indicate that further emphasize the importance of adopting various effective learning models to improve student achievement [3]. Therefore, well-delivered mathematics instruction not only facilitates student understanding but also enhances their overall learning outcomes.

Preliminary research conducted at SD Muhammadiyah Mertosanan revealed that approximately 70% of grade III students scored below the minimum competency standards. This issue was attributed to students' lack of motivation and engagement in classroom activities. Addressing this problem requires the adoption of appropriate solutions, one of which is the use of instructional media. Learning media serve as an important alternative to support the success of the teaching and learning process. In line with this, recent studies highlight that educational media act as essential instruments that significantly influence the effectiveness of teaching and learning [4]. Similarly, earlier studies said that described learning media as any tool that facilitates communication and enables the transfer of knowledge from teachers to students [5]. Media also foster student engagement in the learning process, and since each type of media has distinct characteristics, careful selection is required to ensure its suitability [6]. Furthermore, learning media serve various functions, including as tools for communication, motivation, strengthening comprehension, aligning perceptions, and shaping student character [7]. Based on previous studies, it is known that also argued that learning media act as instruments to clarify concepts, serve as learning resources, and support knowledge acquisition [8].

Among the wide range of learning media available, audio-visual media are particularly effective, as they incorporate sound, images, and video to create a dynamic learning experience. One such tool is Articulate Storyline, an interactive platform designed to engage students actively in the learning process [9]. Similarly, the previous research found that Articulate Storyline is a medium that encourages active student participation through interactive features [9]. For example, previous research confirmed that the use of an interactive learning approach based on Articulate Storyline significantly improved students' ability to solve problems through a pretest–posttest design [10]. In general, well-planned learning concepts delivered through interactive media are believed to foster deeper understanding and active student engagement. Furthermore, another study demonstrated that interactive learning media based on Articulate Storyline were effective in enhancing elementary students' critical thinking and mathematical reasoning skills [11]. This finding indicates that digital media interaction can support problem-solving and strengthen mathematical concepts. In addition, an action research study revealed that differentiated learning supported by Articulate Storyline 3 improved elementary students' mathematics learning outcomes [12]. The students' average scores, initially at 51.92 (pre-class), gradually increased to 83.02 by the end of the second cycle. The statistically significant improvement in student learning outcomes ($p < 0.05$) highlights the effectiveness of this medium in boosting learning achievement. Teachers increasingly adopt Articulate Storyline as it introduces novelty in classroom instruction and enhances student engagement. Supporting this claim, the previous research reported that Articulate Storyline achieved high feasibility ratings from both subject matter experts (81%) and media experts (78%), placing it in the "very good" and "good" categories, respectively [13].

Therefore, the use of Articulate Storyline is considered a promising solution to overcome students' lack of enthusiasm and to improve learning outcomes. Its diverse features, which combine audio, video, and interactive applications, align well with students' characteristics and learning needs. Articulate Storyline is considered highly user-friendly and facilitates the seamless integration of various multimedia elements [14]. Furthermore, it has been proven effective and appropriate in enhancing students' learning outcomes [15]. This study contributes by providing empirical evidence on the effectiveness of Articulate Storyline in mathematics instruction for third-grade students at SD Muhammadiyah Merosanan. The findings are expected to offer an innovative alternative for instructional media that supports the improvement of elementary school students' learning achievements.

2. Method

This research uses a quantitative approach with an experimental design. Experimental research is defined as research in which one or more independent variables are manipulated, while other variables that could potentially influence the results are controlled to a minimum so as not to interfere with the main variables being studied [16]. This approach was chosen because it is suitable for testing the effectiveness of a learning model through a comparison between the experimental group and the control group. The research was conducted at Muhammadiyah Mertosanan Elementary School. The study population was all third-grade students, while the sample consisted of two classes: class III A with 21 students designated as the control group, and class III B with 20 students designated as the experimental group. The sample selection was carried out using a purposive sampling technique based on the suitability of the research design and class availability. The research design used was a Quasi-Experimental Design, specifically a pretest–posttest control group design. In this design, both groups (control and experimental) were given a pretest to determine their initial abilities before treatment. Next, the experimental group received treatment in the form of a specific learning model, while the control group continued to use conventional methods. After treatment, both groups were given a posttest to measure changes in learning outcomes. The research design structure can be seen in Table 1.

Table 1. The research design structure

Group	Pretest	Treatment	Posttest
Experiment	O_1	X (learning model)	O_2
Control	O_3	conventional method	O_4

The description of the research design is as follows. The symbols O_1 and O_3 indicate the pretest scores obtained by the experimental and control groups before being given treatment. The symbols O_2 and O_4 represent the posttest scores of both groups after the learning process has taken place. The symbol X represents the treatment or intervention given to the experimental group, namely the application of the learning model being studied, while the control group did not receive this treatment and continued using conventional methods. Data collection was carried out using several methods: (1) Tests, in the form of pretest and posttest questions to measure students' abilities before and after treatment; (2) Observation, using observation sheets to record students' activities during learning; (3) Documentation, in the form of notes, attendance lists, and relevant school data. The research instruments include pretest and posttest questions, which are compiled based on indicators of critical mathematical thinking skills, and observation sheets, to assess student participation and involvement during the learning process [17]. Data analysis was carried out in several stages with the help of SPSS software, namely: (1) Normality Test, to determine whether the data distribution is normally distributed; (2) Homogeneity Test, to ensure that the data from both groups have the same variance; (3) t-test (Independent Sample t-test), to determine whether there is a significant difference between the learning outcomes of the experimental group and the control group. These analysis steps aim to answer research questions empirically and ensure that the conclusions drawn are valid and reliable.

3. Results and Discussion

The research activity was conducted at Muhammadiyah Elementary School, Mertosanan, from October 2 to 14, 2023. The study involved two classes: the experimental group, Class III

B, consisting of 22 students, and the control group, Class III A, also consisting of 22 students. The control class was taught using conventional learning methods, whereas the experimental class was taught using the Articulate Storyline-based learning approach. In the first meeting, the research was carried out in the control class using conventional learning methods. During this session, a pretest was administered before the mathematics lesson on multiplication was delivered, followed by a posttest after the lesson. In the second meeting, the experimental class received instruction using Articulate Storyline as a learning medium. A pretest was given before the multiplication lesson, followed by a posttest after the lesson was completed. The data obtained from both Class III A and Class III B consisted of pretest and posttest results, which are presented in the following section. The pretest and posttest scores of Class III A, which was taught through conventional methods, are summarized in Table 2.

Table 2. Pretest and Posttest Results of Class III A

Data	Number of Students	Average Score	Lowest Score	Highest Score
Pretest	21	47.86	35	60
postest	21	67.38	50	85

From the data, it can be concluded that the posttest scores are higher than the pretest scores in Class III A. This can be observed from the average posttest score of 67.38, compared to the average pretest score of 47.86. Therefore, the posttest scores are greater than the pretest scores of the students in Class III A. Subsequently, the data from the pretest and posttest results of Class III B, which served as the experimental group using Articulate Storyline as a learning medium during the teaching process, are presented in Table 3.

Table 3. Pretest and Posttest Results of Class III A

Data	Number of Students	Average Score	Lowest Score	Highest Score
Pretest	20	48.50	35	65
postest	20	72.75	55	90

From the data above, it can be concluded that the posttest results of students in Class III B are higher than their pretest results. This is indicated by the average posttest score of 72.75 compared to the average pretest score of 48.50. Therefore, the posttest scores are higher than the pretest scores of the students in Class III B. Based on the results of both classes, a comparative analysis between the pretest and posttest scores of Class III A and Class III B was conducted. A diagram is required to illustrate the improvement in learning outcomes between the control group (Class III A) and the experimental group (Class III B). Fig. 1 presents the comparison of pretest and posttest scores for both groups.

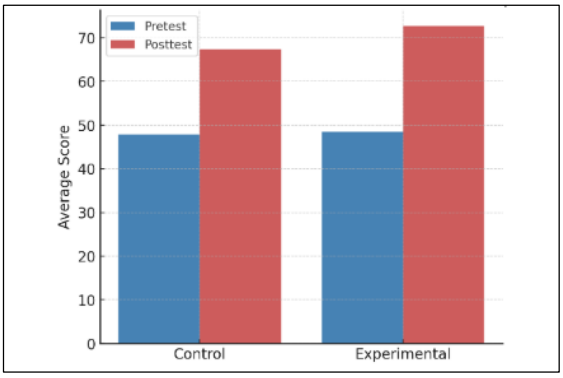

Fig. 1. Comparison of Pretest and Posttest Results of Class III A and Class III B

From the results above, it can be concluded that the posttest score of Class III B, with an average of 72.75, is higher compared to the posttest score of Class III A, which obtained an average score of 67.38. Therefore, the learning outcomes of the experimental class are higher than those of the control class. Subsequently, a normality test was conducted on the pretest and posttest data of Class III A (control group) and Class III B (experimental group). The normality test aims to determine whether the data are normally distributed or not. According to, the normality test serves as a reference for deciding the implementation of the homogeneity test. The results of the normality test for both data sets are presented in Table 4.

Table 4. Normality Test Results of Pretest and Posttest in Control and Experimental Groups

Variabel	Control Class		Experimental Class		Limit	information
	pretest	postest	pretest	postest		
Learning Outcomes	0.062	0.261	0.234	0.132	>0.05	Normal

Based on these results, it can be shown that the normality test calculation for the control group pretest obtained a significance value of 0.062, which is greater than 0.05. Therefore, it can be concluded that the control group pretest data are normally distributed. Meanwhile, the posttest normality test for the control group showed a significance value of 0.261, which is also greater than 0.05. Thus, the control group posttest data are normally distributed. The normality test for the experimental group pretest obtained a significance value of 0.234, which is greater than 0.05. Therefore, it can be concluded that the experimental group pretest data are normally distributed. Similarly, the posttest normality test for the experimental group yielded a significance value of 0.132, which is greater than 0.05. Hence, the experimental group posttest data are also normally distributed. Subsequently, a homogeneity test was conducted on the dataset. According to previous research , the homogeneity test is used to determine whether the variances within populations are equal in parametric statistical tests [18]. The purpose of the homogeneity test in this study is to examine whether the variances of the populations are similar. The results of the homogeneity test for the pretest and posttest data of Class III A and Class III B are presented in Table 5.

Table 5. Homogeneity Test Results

Variable	Sig.	Limit	Conclusion
Learning Outcomes	0.509	>0.05	Homogeneous

From Table 5, it is evident that the significance value is 0.509, which is greater than 0.05. Thus, it can be concluded that the pretest and posttest data are homogeneous. After the data were confirmed to be normally distributed and homogeneous, the next analysis was conducted using a paired sample t-test. Based on the findings of similar research the paired sample t-test is a method used to compare the means of two variables within the same group [19]. The purpose of using the paired sample t-test in this study is to determine the effect of the Articulate Storyline learning media on mathematics learning outcomes of third-grade students at Muhammadiyah Elementary School, Mertosanan. The results of the paired sample t-test are shown in the following section. Based on Table 6, the results of the hypothesis test with a significance value (2-tailed) of 0.000 < 0.05 indicate that the use of Articulate Storyline learning media had a significant effect on mathematics learning outcomes of third-grade students at Muhammadiyah Mertosanan Elementary School.

Table 6. Paired Sample t-Test

Source	t	df	Sig (2-tailed)	Remarks
Post-test and pre-test of the experimental group	-24.000	19	0.000	0.000 < 0.05 = significant effect

This study aimed to examine the effect of applying Articulate Storyline media in mathematics learning on the learning outcomes of third-grade students. The research process included lesson planning by preparing lesson plans and teaching materials. In addition, the study also prepared instruments to collect students' learning outcomes data, such as observation sheets and pre-test/post-test questions. The observation sheets assessed students' skills during the learning process, while the tests consisted of 20 multiple-choice items on multiplication material. Both instruments underwent validation before being implemented in the field. The test questions were validated by expert lecturers and tried out on fourth-grade students at the research site, while the observation sheet was only validated by experts. Reliability tests were also conducted to ensure the consistency of the pre-test and post-test instruments. The instruments were then implemented in two classes: Class A (control group), which used conventional learning methods, and Class B (experimental group), which used Articulate Storyline media. The learning outcomes served as the main measurement tool to determine students' progress. This is accordance with the opinion of Nisa [20], which stated that student learning outcomes are indicators of the success of the learning process, and with Megavitri, et al., which emphasized that learning outcomes reflect the

quality of the learning process [21]. The findings at Muhammadiyah Mertosanan Elementary School indicated that Articulate Storyline significantly improved students' learning outcomes. The control group obtained an average pre-test score of 47.86 and post-test score of 67.38, while the experimental group obtained an average pre-test score of 48.50 and post-test score of 72.75. These results show that students in the experimental group, who used Articulate Storyline, achieved higher outcomes than those in the control group with conventional methods.

The paired sample t-test further confirmed this effect, with a significance value of 0.000 < 0.05, meaning H_a was accepted and H_0 rejected. This indicates that Articulate Storyline media significantly influenced learning outcomes in mathematics (multiplication topic) for third-grade students. This is in line with previous research such as that of Pratiwi et al., which reported that [22]. Articulate Storyline improved student achievement, and Octavia et al., found that mobile learning using Articulate Storyline was authentic, effective, and efficient [23]. Similarly, Mufidah highlighted that Articulate Storyline fulfilled high criteria in improving students' learning outcomes [24]. During the learning process, observations revealed that students were enthusiastic and engaged when learning with Articulate Storyline. This finding is consistent with Sari's article, which emphasized that interactive media using Articulate Storyline is suitable for helping teachers deliver materials and enhancing students' attention [25]. Furthermore, Febrian reported that Articulate Storyline functions as interactive learning media with features similar to Microsoft PowerPoint but with the added advantage of being publishable as web-based content, integrated with other programs, and effective in improving science learning outcomes [26].

4. Conclusion

The study carried out at SD Muhammadiyah Mertosanan from October 2–14, 2023, showed that the use of Articulate Storyline media significantly enhanced third-grade students' mathematics learning outcomes, particularly in multiplication. The experimental class (III B) experienced an increase in average scores from 48.50 (pretest) to 72.75 (posttest), which was higher than the control class (III A), where the scores rose from 47.86 to 67.38. Statistical tests confirmed that the data were both normally distributed and homogeneous, while the paired sample t-test revealed a significance value of 0.000 < 0.05, indicating a positive impact of the media on student achievement. Observations during the lessons also showed increased interest and engagement, suggesting that Articulate Storyline is an effective and innovative tool for improving elementary students' learning outcomes in mathematics.

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