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The Effectiveness of Website-Assisted Learning Multimedia to Improve Mathematics Learning Achievement of Elementary School Students

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Abstract

This study employed a quasi-experimental methodology to ascertain the efficacy of web-assisted learning multimedia in enhancing mathematical learning outcomes among elementary school students. The data was collected using test instruments designed to assess learning outcomes in a structured and objective manner. The efficacy of the web-based multimedia intervention was gauged through the Normalized Gain test, which assesses the extent of improvement in students' mathematical learning outcomes. Subsequent analysis of the dependent variable was conducted using both the Paired Samples t-test and the Independent t-test. The results of the N-Gain test indicated that the experimental group exhibited a significantly greater improvement in mathematics learning achievement compared to the control group. The experimental group achieved a medium category with N-Gain score of 0.68, whereas the control group's score was categorized as low at 0.17. Furthermore, the Paired Samples t-test and Independent t-test demonstrated significance levels below 0.05, thereby corroborating the considerable impact of web-based multimedia on student achievement. These findings underscore the potential of web-based multimedia as an efficacious instructional tool to enhance students' learning achievement. This study offers practical insights to optimize the learning process among young learners.

Keywords: Multimedia Learning; Website; Learning Achievement; Mathematics

INTRODUCTION

The world of education has now entered the era of the Fourth Industrial Revolution. The ongoing digital revolution has begun to penetrate the realm of education (Haleem et al., 2022). The integration of technology into education has become a particular focus for the Indonesian government in its efforts to prepare students to meet the challenges of the Fourth Industrial Revolution, notably through the school digitalization program. Innovations in technology have greatly influenced modern students, as millennials exhibit distinct traits compared to previous generations. Teachers instructing millennial students need to pay close attention to this shift (Demir, 2021). Students are learning more and at a faster pace compared to previous generations (Mantiri, 2014).

Multimedia represents educational tools that incorporate technology in their usage. Over time, it has advanced into a standalone technology, which educators can now employ to enhance the teaching and learning experience (Prasojo & Wibowo, 2014). Multimedia as an instructional medium makes learning more engaging, interactive, and effective, including in Mathematics subjects. Guan et al. (2018) describe multimedia as a combination of various media formats, including symbols, images, text, audio, video, and animation, utilized through technology to enhance students' comprehension and retention of the material. This is reinforced by the opinion of Vaughan (2011, who explains that multimedia is a combination of images, graphics, text, audio, video, and animation, and its presentation is done with the help of computers or other digital devices. There are various forms of learning multimedia, one of which is website-based multimedia.

Mathematics is a subject that is useful for life (Khoo et al., 2024). By mastering mathematics, students can count, process, present data, and make measurements that will be useful in everyday life. Given the significance of mathematics in education, the teaching and learning processes in schools must be engaging and accessible to students. Utilizing diverse teaching media in Mathematics can help students grasp the concepts and learning materials more effectively. The integration of technology is crucial in the learning process of Mathematics because technology can influence the teaching of Mathematics and improve student learning (NCTM, 2000).

The achievement of satisfactory learning achievement is one indicator of the success of the learning process at school. Keller et al. (2017) explain that student learning achievement is shown by students' knowledge of various well-connected facts as the main result of learning. In line with this opinion, Erdawati & Sartika (2022) explained that the results that students leave after carrying out learning activities are called learning achievements. This shows that learning achievement is more related to the realm of knowledge, or it can be said that learning achievement is more related to the cognitive aspects of students. Assessment of learning

achievement is needed in the learning process to determine the level of student learning progress. Guvercin et al. (2014) explain that it can be used to measure student learning achievement.

Students can achieve good learning achievement if there are supporting factors. Teachers have a crucial influence on students' academic achievement. Teacher learning and support have an impact on students' interest in the learning process as well as their achievement in the subject (Yu & Singh, 2018). The delivery of material in learning practices carried out by teachers will have an impact on student success. Teacher support includes providing motivation, stimulating interest in learning, and providing support for students who have difficulty in learning, which has a major effect on the student learning process.

The integration of technology can significantly influence student learning outcomes. Research conducted by Skryabin et al. (2015) found that the incorporation of ICT in educational settings positively affects the academic performance of students in grades 4 and 8, specifically in subjects like science, mathematics, and Indonesian. Additionally, Purmadi and Surjono (2016) demonstrated that utilizing web-assisted teaching materials enhances physics learning outcomes among high school students. Unlike these previous studies, this research specifically targets the application of web-based multimedia for Mathematics instruction, focusing on elementary school students as the research subjects.

The Programme of International Student Assessment (PISA) in 2022 (OECD, 2023) reported that Indonesia ranks 70th out of 81 countries in Math proficiency. This shows that Indonesia ranks 12th lowest in the world. The general picture of the implementation of mathematics learning in elementary schools is generally still teacher-centered, with students memorizing formulas and giving exercises. Fauzan & Yerizon (2013) in his research stated that one of the problems that exist when implementing Mathematics learning in schools is a mechanistic teaching approach. Teachers usually present the material, followed by several examples, after which students are asked to do exercise problems based on these examples. Students are rarely allowed to understand the reasons behind the material taught or to build their own concepts. The learning process causes students to easily forget the lesson and lack understanding of mathematics. Students' lack of understanding of the material causes low learning achievement.

Interviews with three fifth-grade teachers at an elementary school in Yogyakarta, Indonesia, revealed that students' performance in Mathematics is lower than in other subjects. Data indicates that the average score in Mathematics for grade V students is 77.96, which is the lowest among the nine subjects assessed. This suggests that students are having difficulty understanding the mathematics material, which leads to lower achievement. This issue requires attention, as it

impacts student learning and highlights the need for better teaching strategies in Mathematics.

Low learning achievement can be influenced by the teaching carried out by teachers in utilizing teaching media and utilizing teaching materials. The results of interviews with teachers related to the learning process of mathematics, in carrying out learning, show that the teacher presents the subject matter after writing the procedure for working on problems and gives practice problems to students. The results of the interview also provided information about the use of learning media. The teacher said that the only media and learning resources used were student books, teacher books, and sometimes videos obtained from the Internet. This shows that the teacher does not vary in using teaching media.

Student learning achievement can be improved by using multimedia in the learning process (Cheng et al., 2012; Ercan, 2014; Ilhan & Oruç, 2016; Shah & Khan, 2015). The learning multimedia in question is learning media that involves information technology in the form of computers and cell phones, which has at least two elements in the form of text, animation, images, and videos.

Based on the conditions described above, the problems experienced by schools are low student achievement in mathematics learning and the lack of varied learning media used by teachers. Website-assisted multimedia is one of the many learning media that can be used in this digital era. A website is a network that can be accessed, viewed, and can be used to store various documents such as text, data, sound, and video (Smaldino et al., 2014).

Websites are a valuable tool in education, as web-assisted multimedia simplifies the learning process, allowing students to acquire knowledge anytime and anywhere using devices such as computers, laptops, and smartphones. The use of multimedia learning that combines various media elements can help visualize mathematics material. This is because the website includes multimedia resources, including images, sound, video, and animation, so it can be an interactive intellectual tool (Oetomo, 2002). Previous research by Kay (2014) revealed that web-based learning can improve student learning achievement.

Surjono (2013) explains that e-learning, or web-assisted learning media, is a method of delivering educational materials via the Internet that offers very flexible access. Learning materials can be accessed by students anytime and anywhere, making this method very popular due to its flexibility and effectiveness. In addition, the material presented through e-learning can be enriched with a variety of additional learning resources, such as video, audio, graphics, and animation, which makes the learning process more interesting and interactive. Teachers also have the convenience of updating and adding the latest information quickly, ensuring that the material provided is always up-to-date and relevant to the latest developments in the field of study being taught. This is supported by the opinion of Al-Duhani et al.

(2024), Batubara (2018), and Wong et al. (2024), who revealed that one of the advantages of website-assisted learning media is flexible because it can be accessed from anywhere and anytime.

In addition, the advantages of website-assisted learning multimedia include having a wider range of learning media (Raharja et al., 2011), making it easier for students to learn (Bolkan et al., 2016), encouraging students to be more actively involved (Uno & Ma'ruf, 2016), as well as improving learning interactions and easily updating the learning material presented(Munir, 2009). According to the findings of research conducted by Computer Technology Research (CTR), a person's ability to remember information varies depending on the way the information is presented. Research shows that individuals are only able to remember about 20% of the information they see and about 30% of the information they hear. However, when information is delivered simultaneously through sight and hearing, the ability to remember increases to 50%. However, a person can remember 80% of what is seen, then heard, and done simultaneously (Munir, 2012). Thus, learning Mathematics can also utilize the advantages of this web-based multimedia. In addition, Purnama et al. (2023) revealed that future research needs to explore web-based e-learning in schools. Based on the problems previously described, this research is very important in revealing the effectiveness of website-based multimedia in improving the mathematics learning achievement of elementary school students.

METHODS

This research follows a quasi-experimental design consisting of two groups: a control group and an experimental group. In the experimental group, educators and students utilized website-assisted multimedia for their learning activities, whereas the control group continued with traditional learning resources. The overall population for the study comprised 44 students, and a cluster random sampling technique was employed to select participants. Specifically, 22 students from class VC were assigned to the experimental group, while 22 students from class VB formed the control group.

The research implemented a pre-test and post-test structure (Creswell 2015: 606) to measure learning outcomes. Data collection was conducted through a Mathematics achievement test. The effectiveness of the web-based multimedia was assessed using the Normalized Gain (N-Gain) test. To compare learning achievements between the two groups, the study applied the One-Sample Kolmogorov-Smirnov test for normality the Levene statistic test for homogeneity, and performed independent t-tests and paired t-tests for hypothesis evaluation.

RESULTS

1. *Learning using Web-Based Multimedia*

The use of web-based multimedia in the learning process is executed in three phases: the planning phase, the implementation phase, and the evaluation phase. The planning phase is carried out by preparing a lesson plan (RPP), studying the media usage manual for website-based multimedia, and explaining the objectives to be achieved. The implementation phase includes activities where teachers and students carry out learning activities using web-based multimedia. Students, based on the teacher's instructions, open web-based multimedia at the address https://diatika.com and then study the material using the website-assisted multimedia. After that, the material that has been studied is concluded by the teacher and students. During the evaluation phase, teachers and students reflect on whether there are any difficulties they encounter during learning activities and then evaluate the learning that has been done through tests.

The material that students learned in this study is the volume of blocks and cubes and the relationship between square roots and powers of three in mathematics. The website-based multimedia used by researchers can be accessed through the link https://diatika.com, which displays learning material pages as shown in Figure 1.

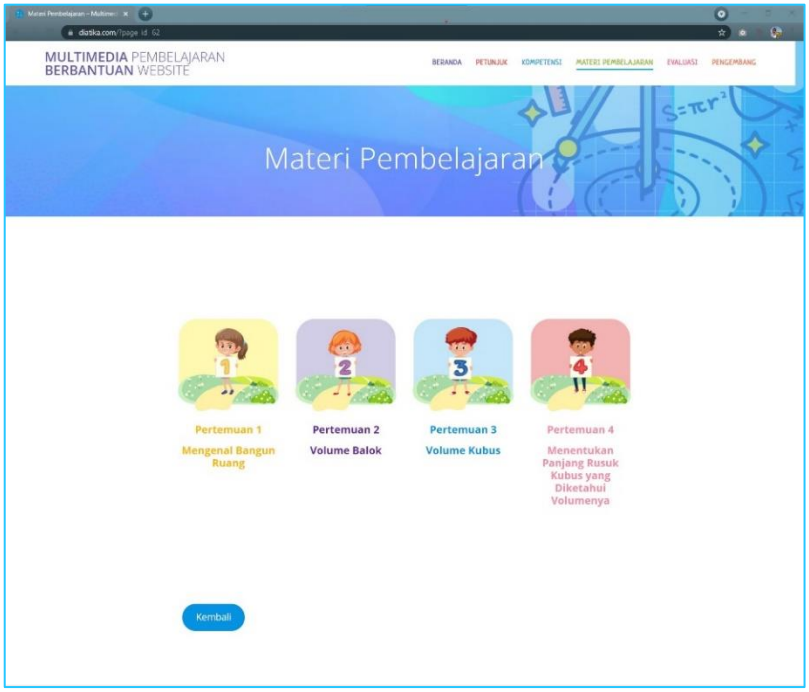

Figure 1 Learning Material Page Display

2. *Achievement Test Results in Learning Mathematics Students*

Pre-tests and post-tests were conducted on control and experimental groups to assess learning achievement in mathematics. The pre-test was conducted to see

how well students learned Mathematics before the learning activities began, while the post-test was conducted to find out how well students learned Mathematics after the learning activities were carried out in the control and experimental groups. Table 1 shows the result data after the pre-test and post-test on learning achievement in Mathematics. Then, the values are analyzed to find out how effective web-based multimedia is in improving student learning achievement in mathematics.

Table 1 Data on Learning Achievement Results in Mathematics

No	Group	Mean		N-Gain	Description
		Pre-test	*Post-test*		
1	Control	40,11	51,93	0,17	Low
2	Experiment	40,45	79,89	0,68	Medium

The data in Table 1 shows that the control group's average pre-test score in Mathematics was 40,11. Following this, the control group learned Mathematics using the provided textbook, and the subsequent post-test yielded an average score of 51,93. The comparison of pre-test and post-test scores indicates an improvement in the control group's Mathematics achievement, reflected in an N-Gain score of 0,17, categorized as low.

In contrast, the experimental group had an average pre-test score of 40,45. This group engaged in Mathematics learning using web-based media, and their post-test average increased significantly to 79,89. The results demonstrate that the experimental group achieved a higher N-Gain score of 0,68, classified as moderate, compared to the control group. Figure 2 illustrates the average Mathematics learning outcomes for students in both the control and experimental groups.

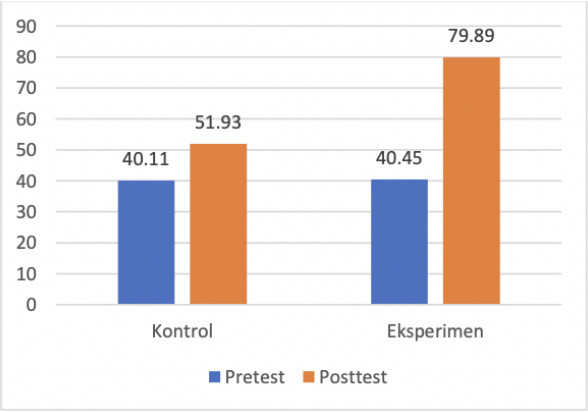

Figure 2 Comparison of Average Mathematics Learning Achievement Score

Figure 2 clearly shows that the Mathematics learning achievement of students in the control group was lower than that of the experimental group. The mean score

of the control group increased by 11,82 with an N-Gain score of 0,17, indicating that they were in the low category, while the mean score of the experimental group increased by 39,44 with an N-Gain of 0,68, indicating that they were in the medium category. This proves that learning that applies website-based multimedia in the experimental group is more effective than ordinary learning in the control group, as seen from the increase in learning achievement in students' Mathematics subjects.

3. Normality Test Results

The results of the normality test conducted using IBM SPSS Statistics 26 software on students' Mathematics learning achievement data when before being given treatment and after being given treatment in both groups, namely the control group and the experimental group, can be seen in Table 2. This test is conducted to ensure that the data obtained from students' Mathematics learning outcomes are normally distributed so that they meet the basic assumptions needed for further statistical analysis. In Table 2, the results of the normality test using the One-Sample Kolmogorov-Smirnov method are presented, which shows the significance level (Sig.) for each type of data in each group.

Table 2 Normality Test Results with One-Sample Kolmogorov Smirnov

No	Group	Data Type	Sig Level	Status	Explanation
1	Control	*Pre-test*	0,071	>0,05	Normal
		Posttest	0,115	>0,05	Normal
2	Experiment	*Pretest*	0,122	>0,05	Normal
		Post-test	0,200	>0,05	Normal

The findings from the normality test indicated that the significance level (Sig.) for the pre-test and post-test data in the control group were 0,071 and 0,115, respectively. In contrast, the experimental group had Sig. values of 0,122 and 0,200. All these values exceeded 0,05, suggesting that the Mathematics learning achievement data for both groups, before and following the treatment, were normally distributed. This normal distribution is crucial for validating the subsequent statistical analyses.

4. Homogeneity Test Results

The homogeneity test conducted using the Levene statistic method on students' Mathematics learning achievement data aims to ensure the similarity of variance between the experimental and control groups. The results of this test are presented in detail in Table 3, which shows the significance level of the pre-test and post-test scores of students' learning achievement for both groups.

Table 3 Homogeneity Testing Results with Levene Statistic

No	Data Type	Sig Level	Status	Explanation
1	Experimental and Control Group Pre-test	0,828	>0,05	Homogeneous
2	Post-test of Experimental and Control Groups	0,078	>0,05	Homogeneous

According to the results of the homogeneity test shown in Table 3, the pre-test and post-test values for students' Mathematics learning achievement in both the control and experimental groups have significance level (Sig.) values exceeding 0,05, specifically 0,828 for the pre-test and 0,078 for the post-test. This suggests that the pre-test and post-test data for Mathematics learning achievement are homogeneously distributed. The equality of variance implies that both groups exhibit similar variability in their Mathematics performance, allowing for more accurate and valid subsequent statistical analyses.

5. Hypothesis Test Results Through Independent Samples t Test

The results of the independent t-test of Maths learning achievement are presented in Table 4.

Table 4 Independent t-test results of Maths Learning Achievement

No	Data Type	Sig Level	Result
1	Experimental and Control Group Pre-test	0,953	H_0 Accepted
2	Post-test of Experimental and Control Groups	0,000	H_0 Rejected

Based on the independent t-test results outlined in Table 4, the pre-test data supports the acceptance of the null hypothesis (H0), indicating no statistically significant difference in initial Mathematics achievement between the experimental and control groups. This suggests that, before the intervention, both groups had comparable levels of mathematical understanding. However, the post-test results present a different scenario, where the null hypothesis is decisively rejected, with a significance value of 0,000. Consequently, the alternative hypothesis (Ha) is accepted for the post-test, demonstrating a statistically significant improvement in Mathematics achievement for students who participated in the web-based multimedia learning program compared to those who followed traditional methods. These results underscore the effectiveness of web-based multimedia as a powerful educational tool capable of enhancing student performance and providing a more engaging learning environment that fosters better academic outcomes.

6. Hypothesis Testing Results Through the Paired Samples t-Test

The results of the paired-sample t-test on Mathematics learning achievement, shown in detail in Table 5, were conducted to evaluate the significant difference between pre-test and post-test scores after the implementation of web-based multimedia learning.

Table 5 Paired Samples t Test Results of Mathematics Learning Achievement

No	Data Type	Sig Level	Status	Description
1	*Pre-test – Post-test*	0,000	<0,05	H_0 Rejected

The results of the paired samples t-test, as shown in Table 5, indicate a significance level of 0,000 for the data on Mathematics learning achievement, which is well below the critical threshold of 0,05. This result necessitates the rejection of the null hypothesis (H0) and the acceptance of the alternative hypothesis (Ha). The data thus confirm that there is a statistically significant difference in students' Mathematics achievement when comparing their performance before and after the introduction of web-based multimedia learning. These findings highlight the effectiveness of integrating web-based multimedia into the educational process, demonstrating its capacity to enhance student outcomes and positively impact their learning experiences in Mathematics.

DISCUSSION

The study's analysis of pre-test and post-test results demonstrated a notable variation in Mathematics learning performance between students who engaged with web-based multimedia and those who did not. This is attributed to the interactive nature of multimedia, which integrates different media formats in a visually appealing and engaging manner, fostering active interaction between learners and the content. Students with various learning styles can be facilitated to better understand the material by presenting varied information. Milovanovic et al. (2016) revealed that multimedia instructional messages involve various media elements to make learning more quickly understood by students. This is because the presentation of material in multimedia learning includes a combination of various elements, such as images, videos, and so on.

Effectiveness of Web-based Multimedia in Improving Students' Ability in Mathematics Based on the two outcomes of the research findings, the standards determined for the effectiveness of web-based multimedia on students' learning achievement are as follows. Firstly, it was seen that students in the experimental group achieved higher learning achievement in Mathematics than the control group; the experimental group had an N-Gain of 0,68, which belongs to the medium

category, and the control group had an N-Gain of 0,17, which belongs to the low category.

Second, based on hypothesis testing, the data on students' mathematics learning achievement obtained Sig. <0,05, or 0,000. This result proves that web multimedia is effective in improving students' ability to study mathematics.

This study's results are consistent with those of Rachmadtullah et al. (2019), who demonstrated that multimedia usage is highly effective in enhancing learning outcomes among elementary school students. In line with these findings, Samsiyah Fajar (2021) also revealed in their research that the utilization of multimedia in learning increases students' learning achievement. In the subject of Maths, the research results (Onah et al., 2020) show that multimedia influences Maths learning achievement. This is reinforced by the findings of Ran et al. (2021), who found that learning using multimedia websites can improve learning achievement in students, especially in the subject of Mathematics.

The web-based multimedia used in this study presents several questions during the learning process, and there is a quiz at the end of each lesson, which is equipped with an assessment score and feedback. The existence of quizzes, assessments, and feedback can improve student learning achievement (Gholami & Moghaddam, 2013; Shirvani, 2009). Quizzes help students to better monitor and recall the learning they have done by providing immediate feedback.

Moore et al. (2004) stated that multimedia places students in a context-rich environment and helps provide a good learning environment. Presenting Mathematics concepts through images and animations helps simplify the material, making it easier for students to comprehend. Web-based multimedia can improve student learning achievement because the presentation reproduces visualization in the form of images, animations, and videos that are appropriate so that students understand them more easily. Students prefer the use of images, animations, and videos rather than writing because they are closer to concrete situations. The use of web-based multimedia does not replace the role of the teacher. This multimedia is used by students, and the teacher increases his role as a student motivator in learning.

Additionally, organizing the material from simple to complex helps students grasp the subject matter more effectively. This approach aligns with Bruner's view (Stapleton & Stefaniak, 2019) that students will better understand the lesson if the material is presented gradually from simple to complex. The material contained in the web-assisted multimedia in this study takes into account Bruner's theory of iconic and symbolic modes of representation so that it can visualize Mathematics concepts to help students get a good mental representation/image with the use of different media elements, which support information processing so that it makes it easier for students to understand learning material. Kumar & Hema (2018) stated

that multimedia can improve students' learning of Maths. Research by Sari & Aydogdu (2020) and Novitasari (2016) also concluded that the use of multimedia in learning can enhance students' comprehension of the material, particularly in Mathematics.

CONCLUSION

The findings of this study demonstrate that web-based multimedia is an effective tool for enhancing Mathematics achievement among elementary school students. Analyses of N-Gain scores, along with independent t-tests and paired t-tests, showed that students in the experimental group attained significantly higher Normalized Gain (N-Gain) scores compared to their counterparts in the control group. Specifically, both the independent t-test and Paired Samples t-test indicated a significance level of less than 0,05. These results make a valuable contribution to the field of education by illustrating that the incorporation of web-based multimedia technology serves as a highly effective instructional strategy for improving students' learning outcomes in Mathematics. Furthermore, this research enriches the existing literature on technology use in primary education, especially in the context of mathematics instruction, and offers practical insights for educators seeking to integrate web-based multimedia into their curricula to enhance student achievement in Mathematics.

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