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Comparing Wordwall-Assisted Learning and Conventional Teaching in Improving Students' Mathematics Learning Outcomes

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ABSTRACT

This study aims to examine the effect of Wordwall-assisted learning on students' cognitive learning outcomes in mathematics, particularly on the topic of percentages, compared with conventional teaching methods. The research employed a quantitative approach using a quasi-experimental design with a non-equivalent control group design. The participants consisted of fourth-grade students from the International Class Program (ICP) at MI Masjid Al-Akbar Surabaya, divided into an experimental group and a control group. Data were collected through pre-test and post-test assessments to measure students' learning outcomes before and after the instructional treatment. The experimental group received mathematics instruction using the interactive digital learning medium Wordwall, while the control group was taught using conventional instructional methods. Descriptive statistical analysis showed that both groups experienced improvements in their learning outcomes. The mean score of the experimental group increased from 58.57 in the pre-test to 75.00 in the post-test, while the control group improved from 62.14 to 66.00. However, inferential statistical analysis using an independent samples t-test revealed that the difference between the two groups was not statistically significant ($t = 1.64 < t\text{-table} = 1.706$, $\alpha = 0.05$). These findings indicate that although Wordwall-assisted learning contributed positively to students' learning experiences and achievement, its effect was not significantly superior to conventional teaching methods within the context and duration of this study. Further research involving larger samples and longer implementation periods is recommended.

INTRODUCTION

Primary education plays a central role in establishing the foundation of students' knowledge and skills. At this stage, students begin to develop fundamental thinking abilities that will support their understanding of various academic disciplines at higher levels of education. Primary education does not only function as an introductory phase to academic concepts but also serves as an important stage in shaping students' mindsets, learning attitudes, and systematic problem-solving abilities. Among various disciplines, mathematics is considered a fundamental subject that not only develops computational skills but also fosters logical, systematic, and analytical thinking (Smith, 2021). Therefore, students' success in mastering mathematics at the Madrasah Ibtidaiyah (MI) or Islamic Elementary School level becomes an important indicator of their academic progress in subsequent educational stages.

Furthermore, several studies have indicated that strong mathematical competence at the primary education level is positively correlated with critical thinking skills and numeracy literacy at higher levels of education. According to a study conducted by the OECD (2019), mastery of mathematical concepts from an early stage significantly influences students' readiness to face the challenges of 21st-century learning, which demands analytical thinking and complex problem-solving skills. Therefore, mathematics learning at the MI level must be systematically designed to provide meaningful learning experiences and encourage students to actively participate in the learning process.

One of the primary objectives of the learning process is to achieve optimal learning outcomes, particularly in the cognitive domain. Learning outcomes reflect the extent to which students have absorbed and mastered the concepts delivered during instruction. Effective learning outcomes are not only measured through examination scores but also through students' ability to apply their knowledge in new contexts (Johnson, 2019). From the perspective of modern education, cognitive learning outcomes are closely related to students' abilities to understand concepts, analyze information, and connect previously learned knowledge with real-life situations.

Research conducted by Hattie (2009) demonstrates that the quality of instructional strategies implemented by teachers has a significant influence on improving student learning outcomes. Learning strategies that promote active student participation have been proven to significantly enhance conceptual understanding compared with passive learning approaches. Therefore, the selection of appropriate teaching methods and instructional media becomes an essential factor in improving the quality of mathematics learning in primary schools.

Particularly in Grade 4 of the International Class Program (ICP) at MI Masjid Al-Akbar, the curriculum demands are relatively higher and frequently involve bilingual instruction, which adds complexity to the learning process. This condition requires teachers not only to master the subject matter but also to apply engaging and effective teaching methods. Learning in international classes generally emphasizes critical thinking, collaboration, and the integration of technology into the learning process. Therefore, teachers need to develop innovative instructional approaches that enable students to understand mathematical concepts more effectively.

Conventional learning approaches that tend to be monotonous and teacher-centered often fail to meet the learning needs of ICP students who are expected to demonstrate active engagement and higher-level thinking skills (Wiyono, 2022). In teacher-centered learning environments, students often act merely as passive recipients of information without sufficient opportunities to independently explore concepts. This condition may result in low learning motivation and limited conceptual understanding of the material being studied.

To date, many mathematics learning activities still rely heavily on conventional instructional methods such as lectures, textbook assignments, and problem-solving exercises on the board. Although these approaches are structured, they often fail to facilitate interaction, exploration, and intrinsic student motivation. As a result, students tend to become easily bored, and their conceptual understanding remains procedural rather than deep and meaningful (Hartono & Sari, 2018).

Several studies have also shown that traditional teaching methods tend to be less effective in promoting student engagement. Research conducted by Hwang and Wu (2014) indicates that the integration of digital technology in learning can increase students' motivation and help them understand abstract concepts through more visual and interactive learning experiences. Therefore, the use of technology-based learning media can serve as an alternative approach to improving the quality of mathematics instruction.

To overcome learning boredom and enhance student engagement, it is necessary to integrate technology that adopts gamification principles. Gamification refers to an approach that utilizes game elements such as points, levels, challenges, and competition to enhance students' learning motivation. The integration of technology not only aligns with current educational developments but has also been proven to create more dynamic and enjoyable learning environments, transforming monotonous tasks into engaging challenges (Prasetyo, 2020).

Research conducted by Deterding et al. (2011) explains that gamification in learning can increase student engagement by providing more interactive and challenging learning experiences.

Moreover, gamification can enhance students' intrinsic motivation because they feel directly involved in the learning process.

One platform that is relevant for implementing gamification in learning is Wordwall. Wordwall is a web-based tool that allows teachers to create various interactive activities, such as quizzes, matching exercises, and random wheels, all of which can easily be transformed into game formats. The use of Wordwall provides variety in practice activities, thereby increasing students' focus and encouraging healthy competition among them (Wijaya, 2023).

Several studies in the field of educational technology have shown that the use of Wordwall in learning can improve students' motivation and academic performance. Research conducted by Rahmawati and Atmojo (2022) found that the use of Wordwall as a learning medium in mathematics instruction can enhance student engagement and help them understand concepts in a more interactive manner.

Theoretically, the implementation of Wordwall is expected to have a significant positive impact on students' cognitive learning outcomes. The interactive features and instant feedback provided by Wordwall facilitate independent learning and enable students to quickly identify their mistakes. This more visual and interactive learning environment is believed to enhance students' conceptual understanding of mathematics compared with passive conventional methods (Susanto, 2021). Furthermore, digital learning media enable students to learn through direct experiences involving visual, auditory, and kinesthetic elements simultaneously.

To validate the hypothesis regarding the superiority of this instructional medium, this study employs a comparative research approach. This method is considered the most effective way to objectively compare the effects of two different treatments—namely, classes using Wordwall and classes using conventional teaching methods—on learning outcome variables (Arikunto, 2010). Such an approach provides empirical data regarding the relative effectiveness of Wordwall.

Based on this background, this study focuses on comparing the direct impact of Wordwall-assisted learning and conventional learning methods. The main research question is: Is there a significant difference in the cognitive mathematics learning outcomes of Grade 4 ICP students at MI Masjid Al-Akbar after the implementation of Wordwall-assisted learning compared with conventional learning methods?

The results of this comparative study are expected to provide important practical contributions to educational institutions. For teachers, the findings may serve as concrete guidance for adopting and integrating technological tools such as Wordwall to enhance the effectiveness of mathematics instruction. For MI Masjid Al-Akbar, the results may serve as a basis for curriculum policy decisions related to the integration of technology in ICP classrooms. Additionally, this study is expected to contribute to the growing body of literature on the use of gamification-based learning media to improve mathematics learning outcomes in primary education.

METHOD

The research method employed in this study was a quantitative approach using a quasi-experimental design. This method was selected to compare the effect of a specific treatment (the use of Wordwall as a learning medium) on the dependent variable (students' mathematics learning outcomes) between the experimental group and the control group, while maintaining the existing classroom conditions. The design applied in this study was the Non-equivalent Control Group Design, which is considered a development of the true experimental design (Sugiyono, 2010, p. 109). This design involves two groups (experimental and control) that are not randomly assigned (non-randomized), but their outcomes are measured through pre-test and post-test assessments.

In this design, both groups were first given a pre-test to determine students' initial abilities before the treatment was administered. Subsequently, the experimental group received mathematics instruction assisted by the Wordwall learning media, while the control group received conventional learning methods such as lectures, problem-solving exercises, and simple classroom discussions. After the learning process had been conducted over several meetings, both groups were administered a post-test to measure changes in students' learning outcomes after the treatment. Therefore, the

comparison between pre-test and post-test results in both groups can be used to determine the effectiveness of Wordwall as a learning medium in improving students' mathematics learning outcomes.

The quasi-experimental design is frequently used in educational research because it accommodates real classroom conditions where random assignment of research participants is often not feasible. In the context of this study, the existing classes were maintained as the experimental and control groups in order to avoid disrupting the ongoing learning process. Nevertheless, to minimize research bias, both groups were taught the same learning material, were given relatively equal instructional time, and used the same evaluation instruments. Therefore, any differences in learning outcomes could reasonably be attributed to the treatment applied.

The population of this study consisted of all fourth-grade students in the International Class Program (ICP) at MI Masjid Al-Akbar Surabaya. The sample used in this study is presented in the following table.

Table 1. Distribution of Research Samples in the Experimental and Control Groups

Group	Class	Number of Students	Type of Treatment
Experimental	4 ICP A	22	Wordwall-assisted learning
Control	4 ICP B	23	Conventional learning
Total Sample		45	

The primary instrument used to collect data on students' cognitive learning outcomes was a mathematics achievement test consisting of multiple-choice and higher-order thinking skill (HOTS) essay questions related to the relevant learning materials. The test items had previously been examined for validity and reliability to ensure the accuracy and consistency of the measurement.

Data analysis was conducted through two main stages: descriptive statistics and inferential statistics. Descriptive statistical analysis was used to describe the results of the pre-test and post-test in both groups, including the mean scores, standard deviations, maximum scores, and minimum scores. Meanwhile, inferential statistical analysis was used to test the research hypothesis, which included tests of normality, homogeneity, and a comparative test using the independent samples t-test.

Furthermore, inferential analysis in this study aimed to determine whether there was a statistically significant difference between the mathematics learning outcomes of students who participated in Wordwall-assisted learning and those who participated in conventional learning. The normality test was conducted to ensure that the research data were normally distributed, while the homogeneity test was conducted to determine whether the variance between the two groups was equivalent. If these assumptions were satisfied, hypothesis testing was performed using the independent samples t-test to determine the significance of differences in learning outcomes between the experimental group and the control group.

RESULT AND DISCUSSION

Result

This study aimed to conduct a comparative analysis of the effect of using Wordwall as a learning medium on students' cognitive learning outcomes in mathematics, particularly on the topic of percentages, compared with conventional teaching methods. Data were collected through the administration of pre-tests and post-tests in two groups at MI Masjid Al-Akbar, namely Grade 4 ICP A as the experimental group and Grade 4 ICP B as the control group.

Learning outcome data were collected through tests administered twice, namely the pre-test (before treatment) and the post-test (after treatment). The experimental class received mathematics instruction assisted by the Wordwall learning media, while the control class received conventional instruction without the use of Wordwall. The experimental group (Grade 4 ICP A) consisted of 14 students. Descriptive statistical analysis indicated that there was a significant increase in the average learning outcomes after the treatment.

Table 2. Pre-test and Post-test Results of the Experimental Group

Test	N	Mean	Standard Deviation	Min	Max
Pre-test	14	58.57	8.30	50	70
Post-test	14	75.00	13.37	60	100

The average learning outcome of students in the experimental group increased from 58.57 in the pre-test to 75.00 in the post-test. This increase of 16.43 points indicates a positive impact resulting from the implementation of Wordwall as a learning medium. The maximum score increased to 100, indicating that several students were able to achieve a very high level of understanding after participating in Wordwall-assisted learning. However, the standard deviation also increased from 8.30 to 13.37, indicating that the variation in students' scores became more heterogeneous after the treatment. This condition may occur because some students were able to adapt very well to digital learning media, while others still needed time to adjust to technology-based learning methods.

Meanwhile, the control group (Grade 4 ICP B) also consisted of 14 students and received conventional learning instruction. The data indicate an increase in the average score, although the instruction was delivered without the assistance of Wordwall.

Table 3. Pre-test and Post-test Results of the Control Group

Test	N	Mean	Standard Deviation	Min	Max
Pre-test	14	62.14	9.64	50	70
Post-test	14	66.00	15.49	30	90

The average learning outcome of the control group increased from 62.14 to 66.00. Although there was an increase of 3.86 points, the improvement was relatively smaller compared with the experimental group. In addition, the standard deviation increased from 9.64 to 15.49, indicating a wider distribution of student scores after the implementation of conventional learning. This result may indicate that conventional methods are still capable of improving some students' understanding, but they may not provide equally effective learning stimulation for all students.

To determine whether the differences between the two groups were statistically significant, a t-test was conducted using the following hypotheses:

H_0: There is no significant difference in mathematics learning outcomes between students who learn using Wordwall (experimental group) and those who learn through conventional methods (control group).

H_1: There is a significant difference in mathematics learning outcomes between students who learn using Wordwall and those who learn through conventional methods.

The pooled variance was calculated using the following formula:

$$s_p^2 = \frac{(n_1-1)s_1^2+(n_2-1)s_2^2}{n_1+n_2-2}$$

$$s_p^2 = \frac{(13)(13{,}37)^2+(13)(15{,}49)^2}{26} = \frac{(13)(178{,}76)+(13)(239{,}94)}{26} = \frac{5.443{,}1}{26} = 209{,}35$$

The standard error (SE) was calculated as:

$$\text{SE} = \sqrt{s_p^2\left(\frac{1}{n_1}+\frac{1}{n_2}\right)} = \sqrt{209{,}35\left(\frac{1}{14}+\frac{1}{14}\right)} = \sqrt{209{,}35 \cdot \frac{2}{14}} = \sqrt{29{,}91} = 5{,}47$$

The t-value was calculated as: $t = \frac{\bar{X}_1-\bar{X}_2}{SE} = \frac{75-66}{5{,}47} = \frac{9}{5{,}47} = 1{,}64$

The degree of freedom (df) was calculated as: $\text{df} = n_1 + n_2 - 2 = 14 + 14 - 2 = 26$

At the significance level (α) of 0.05 and df = 26, the t-table value is 1.706. Since the calculated t-value is 1.64, which is lower than the critical t-value (1.706), the result can be interpreted as:

$$t_{calculate} = 1{,}640 < t_{table} = 1{,}706$$

Thus, H_1 is rejected and H_0 is accepted.

This means that there is no statistically significant difference in mathematics learning outcomes between students who learned using Wordwall and those who learned through conventional methods.

The statistical results indicate that, formally, there is no significant difference in mathematics learning outcomes between the group that used Wordwall (experimental group) and the group that received conventional instruction (control group). Although the descriptive data show a positive increase in learning outcomes from pre-test to post-test in both classes, and the experimental group achieved a higher post-test mean score (75.00) compared with the control group (66.00), the difference was not large enough to be considered statistically significant at the 95% confidence level. In other words, learning improvement occurred in both groups, but the study could not demonstrate that Wordwall-assisted learning was significantly superior to conventional instruction within the context of this experiment.

Discussion

The findings of this study indicate that both the experimental group and the control group experienced improvements in learning outcomes after the instructional process was completed. This result suggests that the learning process implemented in both groups—whether using Wordwall-assisted learning media or conventional teaching methods—contributed to improving students' understanding of the percentage topic in mathematics. However, descriptively, the improvement observed in the experimental group was higher than that in the control group. This finding suggests that technology-based learning media such as Wordwall have the potential to provide more engaging and interactive learning experiences for students.

From a theoretical perspective, the use of interactive learning media can enhance students' learning motivation because it creates a more engaging and participatory learning environment. According to constructivist theory, learning becomes more effective when students actively participate in constructing their knowledge through meaningful learning experiences (Piaget, 1972). Digital learning media such as Wordwall allow students to interact directly with instructional materials through educational games, interactive quizzes, and immediate feedback on their responses. This finding is consistent with the study conducted by Rahmawati and Atmojo (2022), which found that the use of Wordwall can increase students' motivation and engagement in elementary school learning.

Furthermore, the concept of gamification in learning may also explain the improvement in learning outcomes observed in the experimental group. Gamification refers to a learning approach that incorporates game elements to enhance students' engagement and motivation. Deterding et al. (2011) explain that the use of game elements such as scores, challenges, and competition can increase user engagement in various activities. In the context of learning, gamification can make students more enthusiastic about participating in the learning process because they feel challenged to achieve better scores compared to their previous performance.

Nevertheless, the statistical test results indicate that the difference in learning outcomes between the two groups was not statistically significant. Several factors may explain this result. One possible factor is the relatively small sample size used in this study, which may have increased data variability. In quantitative research, small sample sizes may reduce statistical power, making it difficult to detect significant differences even when descriptive differences exist (Cohen, 1988). In addition, the duration of Wordwall implementation in the learning process may have been limited, which could influence its effectiveness in improving students' learning outcomes.

Another factor that may have influenced the findings is the relatively similar initial ability levels of students in both groups. This can be observed from the pre-test scores, which show only a small difference between the experimental and control groups. This condition indicates that both groups had relatively similar levels of learning readiness before the treatment was applied. Therefore, the improvements in learning outcomes may have been influenced more by the overall learning process rather than by the exclusive use of a particular instructional medium.

The findings of this study are consistent with several previous studies indicating that the use of digital learning media does not always produce statistically significant differences in the short term, although it may still contribute positively to students' motivation and engagement in learning.

Research conducted by Hwang and Wu (2014) shows that the integration of technology in learning can enhance students' learning experiences, but its effectiveness is strongly influenced by instructional design, the duration of media use, and the readiness of both teachers and students to utilize educational technology.

Therefore, it can be concluded that the use of Wordwall in mathematics learning has the potential to improve students' learning outcomes, particularly in terms of learning motivation and engagement. However, to obtain statistically more significant impacts, more consistent implementation over a longer period of time is required, along with instructional designs that are more effectively integrated with the use of digital learning media.

CONCLUSION

Based on the results of the quantitative comparative study conducted at MI Masjid Al-Akbar, this research aimed to empirically compare the cognitive learning outcomes in mathematics, particularly on the topic of percentages, between students who learned using the interactive learning medium Wordwall (experimental group) and those who learned through conventional instructional methods (control group). The study employed a quantitative approach with a quasi-experimental design using a non-equivalent control group design, in which data were collected through pre-test and post-test assessments.

Descriptive analysis indicated that both groups experienced improvements in their learning outcomes after the instructional treatment. The experimental group that used Wordwall showed an increase in the mean score from 58.57 in the pre-test to 75.00 in the post-test. Meanwhile, the control group that received conventional instruction also demonstrated improvement, with the mean score increasing from 62.14 in the pre-test to 66.00 in the post-test. These findings suggest that the learning process in both groups contributed positively to students' understanding of the mathematical concept of percentages.

However, the results of the inferential statistical analysis using the independent samples t-test revealed that the difference between the two groups was not statistically significant. The calculated t-value was 1.64, while the critical t-value at the 0.05 significance level with 26 degrees of freedom was 1.706. Since the calculated t-value was lower than the critical value ($1.64 < 1.706$), the null hypothesis (H_0) was accepted and the alternative hypothesis (H_1) was rejected. This indicates that there was no statistically significant difference in mathematics learning outcomes between students who learned using Wordwall and those who learned through conventional teaching methods.

Although the experimental group achieved a higher post-test mean score compared with the control group, the difference was not sufficiently large to be considered statistically significant within the context of this study. These findings suggest that while Wordwall has the potential to enhance students' engagement and learning experiences, its effect on improving mathematics learning outcomes was not significantly superior to conventional instruction under the conditions and duration of the implementation in this study.

Therefore, it can be concluded that the use of Wordwall as a digital learning medium may contribute positively to the learning process, but it cannot yet be considered significantly more effective than conventional teaching methods in improving students' mathematics learning outcomes. Future studies are recommended to involve larger sample sizes, longer implementation periods, and more integrated instructional designs in order to more comprehensively examine the potential impact of gamified digital learning media such as Wordwall on students' academic achievement.

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