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Enhancing Students' Learning Motivation through Wordwall Educational Games in Mathematics

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ABSTRACT

Learning motivation is a crucial component that determines students' academic success, particularly in subjects such as mathematics, which are often perceived as difficult and less appealing. The low level of students' motivation in mathematics is one of the key factors contributing to the insufficient attainment of basic competencies at the elementary school level. Therefore, innovative approaches are needed to effectively enhance student engagement and enthusiasm for learning. This study aims to analyze the effect of using Wordwall-based educational games on elementary school students' motivation in learning mathematics. A quantitative approach was employed with a one-group pretest–posttest design. The research subjects were 30 fourth-grade students at SD Negeri 2 Jeumpa, selected through a total sampling technique. The data collection instrument was a validated learning motivation questionnaire with high reliability. Data were obtained through measurements conducted before and after the implementation of learning using Wordwall. The results of the analysis, using a paired sample t-test, revealed a significant increase in students' learning motivation ($p < 0.05$), with the mean posttest score being higher than the pretest score. Most students who were initially categorized at a moderate level showed improvement to high and very high categories after the treatment. These findings indicate that the use of Wordwall contributes positively to enhancing students' learning motivation in mathematics. This study provides novel evidence of the potential of game-based learning platforms, particularly Wordwall, in fostering motivation in mathematics learning, an area that remains underexplored in the Indonesian elementary school context. The study recommends the integration of Wordwall as an innovative strategy to increase student engagement, with further development focusing on cognitive aspects and learning outcomes.

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Introduction

Education is a fundamental process in developing human potential, not only for transferring knowledge and skills but also for shaping character and social competence. The Indonesian Law No. 20 of 2003 on the National Education System emphasizes that education aims to develop learners' potential to become individuals who are faithful, virtuous, capable, creative, and independent. Education plays a crucial role in individual development, particularly in today's digital era. The rapid advancement of technology has brought many changes in various aspects of life, including education (Awalyah et al., 2024). This development creates opportunities to improve learning processes but also presents challenges for teachers to find more effective and engaging methods, especially in subjects considered difficult, such as mathematics.

Mathematics is a fundamental discipline that fosters discipline and develops human reasoning skills, making it applicable to current technological advancements (Zarkasi & Lutfianto, 2017). As one of the core subjects in the primary and secondary education curriculum, mathematics contributes not only to mastering numerical and logical concepts but also to developing systematic thinking and problem-solving skills (Chang et al., 2020; El Mouhayar, 2018; Yao, 2022). However, many students struggle with abstract mathematical concepts, often due to their low interest and motivation to learn the subject (Nurhikmah et al., 2024). Mathematics learning is frequently perceived as intimidating, tedious, and confusing because of overly theoretical and less contextual approaches (Kollosche, 2021). Therefore, there is a need for strategies that can bridge abstract mathematical concepts with students' concrete experiences. Teachers should implement innovative methods that make mathematics learning more meaningful, enjoyable, and motivating. One emerging approach is the integration of interactive technology and educational games.

The use of educational games is one effective way to address current challenges in education. According to Clarisa (2021), leveraging available and continuously evolving technology, educational games can serve as effective learning tools. They make learning more enjoyable and directly engage students with the subject matter, helping them understand difficult concepts. Teachers can design and adapt educational games according to specific learning objectives (Asmadi, 2022). By incorporating game elements, educational games make content more interesting and interactive, which ultimately increases student attention and participation (Nurdiana & Asmah, 2022).

One widely used game-based learning platform among educators is Wordwall. Wordwall provides various interactive quiz-based activities (Zulfah, 2023). According to Walidah et al. (2022), Wordwall is an interactive educational game that has been extensively utilized in classrooms. It offers a range of educational challenges designed to create a more enjoyable and engaging learning experience. Moreover, the platform encourages active student participation in the learning process (Zakiyah & Satianingsih, 2024). Wordwall not only makes learning more interactive but also fosters a relaxed and engaging classroom environment. Teachers can use it to introduce new concepts or review previously taught material (Jannah et al., 2024). Wordwall can also be developed by teachers as a teaching tool in mathematics to increase student activity and enthusiasm (Atika & Amelia, 2024). With customizable features such as quizzes, puzzles, and other interactive activities, Wordwall allows teachers to adapt learning content to specific needs. A study by Hadi et al. (2024) further confirmed that Wordwall enhances student engagement and has a positive impact on learning outcomes at the elementary school level.

Every learner has different ways and motivations for learning. Some are highly enthusiastic, while others show low motivation, influenced by various factors. Understanding

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these factors is essential in education, as motivation significantly contributes to academic success. Motivation is the driving force that compels individuals to act toward specific goals. According to Rafika (2021), motivation is a conscious effort to direct, encourage, or influence others to perform activities that achieve desired outcomes. Learning motivation can be categorized into intrinsic motivation, which arises internally from the learner, and extrinsic motivation, which emerges due to external influences such as encouragement from others (Arianti, 2018). Motivation plays a crucial role in sustaining students' enthusiasm to achieve their goals (Lutfiwati, 2020). As noted by Umam (2024), learning motivation is one of the determining factors of success in the teaching and learning process. Highly motivated students tend to be more disciplined, engaged, and persistent, while those with lower motivation often struggle to maintain enthusiasm and consistency in their efforts.

Preliminary observations revealed that many students experience difficulties in understanding basic mathematical concepts, primarily due to low learning motivation. Mathematics is often perceived as difficult and confusing, discouraging students from engaging in learning. This challenge is particularly evident in mixed arithmetic operations, where students struggle to apply the correct order of operations. The problem is further exacerbated by the reliance on conventional teaching methods, such as lectures and repetitive drills, which fail to actively engage learners. Teacher-centered approaches often result in boredom and disinterest, reducing student participation and hindering deeper comprehension. Thus, innovative and student-centered teaching strategies are required to foster greater interest, motivation, and understanding—particularly in topics such as mixed arithmetic operations.

This study aims to enhance students' motivation in learning mathematics, specifically in mixed arithmetic operations, by utilizing Wordwall-based educational games. Previous studies have demonstrated the effectiveness of educational games in improving students' learning motivation (Lisnaini et al., 2024). Similarly, Nisa & Susanto (2022) reported that Wordwall-based games in mathematics learning have a positive impact on student motivation. By providing specially designed activities, students can practice mathematics through more enjoyable approaches. This method not only increases students' learning interest but also strengthens their retention of the material.

However**,** limited research has specifically examined the integration of Wordwall into mathematics learning to address motivation challenges in the context of Indonesian elementary schools. This gap highlights the novelty of the present study, which provides empirical evidence on how Wordwall-based educational games can be applied to foster students' motivation in mixed arithmetic operations. Based on this background, the research question guiding this study is: To what extent does the use of Wordwall-based educational games influence elementary school students' motivation in learning mathematics, particularly in mixed arithmetic operations?

Method

Settings

This study employed a quantitative approach with a pre-experimental design using a one-group pretest–posttest model. This design was chosen to examine changes in students' learning motivation before and after the intervention without involving a control group. The subjects were given a pretest to measure their initial level of motivation, followed by an intervention in the form of learning activities using the Wordwall educational game. After the learning process, a posttest was administered to determine the changes in motivation. This design was considered appropriate for a single-class setting, which represented the entire population, and enabled the identification of changes that might be attributed to the treatment.

Population and Sample

The population refers to the entire group of individuals targeted in a study, while the sample is a subset of the population representing it as a whole (Mushofa et al., 2024). The population of this research comprised all 30 fourth-grade students of SDN 2 Jeumpa. The sampling technique applied was total sampling (Putri et al., 2022), meaning the entire population was included as the sample.

Instruments

A research instrument is a tool used to collect the required data (Syahroni, 2022). The instrument in this study was a Likert-scale learning motivation questionnaire, validated by one lecturer and one mathematics teacher. The questionnaire used a five-point scale, where respondents indicated their level of agreement with each statement, ranging from Strongly Disagree (1) to Strongly Agree (5). It consisted of 15 statements, developed based on learning motivation indicators proposed by Nisa & Susanto (2022), including: willingness to learn without coercion, the need to achieve learning goals, enthusiasm for learning, persistence, and efforts to achieve good learning outcomes. The questionnaire contained 10 positive and 5 negative statements. The validity and reliability of the instrument were tested using SPSS, and the results showed that all items were valid and reliable. Consistent with Waruwu et al. (2025), validity and reliability are essential aspects in quantitative research to ensure accurate and consistent data.

Table 1. Validity Test Results

Statements	r-calculated	r-table	Description
1	0,647	0,361	Valid
2	0,543	0,361	Valid
3	0,567	0,361	Valid
4	0,513	0,361	Valid
5	0,631	0,361	Valid
6	0,553	0,361	Valid
7	0,548	0,361	Valid
8	0,547	0,361	Valid
9	0,676	0,361	Valid
10	0,550	0,361	Valid
11	0,509	0,361	Valid
12	0,527	0,361	Valid
13	0,619	0,361	Valid
14	0,548	0,361	Valid
15	0,517	0,361	Valid

As shown in Table 1, all items met the requirement where r-calculated > r-table (0.361 for N = 30), indicating that all items were valid.

Table 2. Reliability Test Results

Cronbach`s Alpha	N of Items
0,842	15

Based on Table 2, the Cronbach's Alpha value was 0.842, which exceeds the threshold of 0.60, thus confirming the instrument's reliability. According to Mónus (2020), behavioral research instruments generally require a Cronbach's Alpha of at least 0.60 or higher.

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Data Collection and Analysis

Data were collected using the learning motivation questionnaire. The Likert-scale scoring alternatives for positive and negative items are presented below:

Table 3. Likert Scale Scoring Alternatives

Positive Statements	Score	Negative Statements	Score
Strongly Agree (SA)	5	Strongly Agree (SA)	1
Agree (A)	4	Agree (A)	2
Neutral (N)	3	Neutral (N)	3
Disagree (D)	2	Disagree (D)	4
Strongly Disagree (SD)	1	Strongly Disagree (SD)	5

Learning motivation was categorized into five levels: very high, high, moderate, low, and very low. According to Arifin in Yenni & Sukmawati (2020), the categorization is based on the total number of items and possible responses. The calculated intervals were as follows:

Table 4. Learning Motivation Categories

No.	Interval	Category
1	64–75	Very High
2	52–63	High
3	40–51	Moderate
4	28–39	Low
5	15–27	Very Low

Data were analyzed using descriptive statistics to summarize students' learning motivation scores, followed by inferential statistics to test the research hypothesis. Specifically, a paired-sample t-test was employed to examine whether there were significant differences in students' learning motivation before and after the implementation of Wordwall-based educational games (Nawawi, 2020). The hypotheses tested in this study were formulated as follows:

- H_0: There is no significant difference in students' learning motivation before and after using Wordwall-based educational games in mathematics learning.
- H_1: There is a significant difference in students' learning motivation before and after using Wordwall-based educational games in mathematics learning.

A significance level of $p < 0.05$ was set as the threshold for statistical decision-making. Accordingly, H_0 would be rejected if the p-value was below this threshold, indicating a significant difference between pretest and posttest scores. Conversely, if the p-value was equal to or greater than 0.05, H_0 would be retained, suggesting no significant difference in students' motivation levels.

Results

This section presents the findings of the study on the effect of using Wordwall-based educational games on students' learning motivation in mathematics. Data were collected through a validated and reliable learning motivation questionnaire. The analysis was carried out by comparing pretest and posttest results to identify changes in students' motivation levels before and after the implementation of Wordwall as a learning medium. The results are presented in the form of descriptive quantitative data and inferential statistical tests to evaluate the previously formulated hypotheses.

The questionnaire distributed to the students yielded two sets of results, namely before and after the use of Wordwall-based learning media to enhance the learning motivation of fourth-grade students. The results are presented below.

Table 5. Students' Learning Motivation Categories Before and After Treatment

Interval	Category	Before (Frequency)	Before (%)	After (Frequency)	After (%)
64–75	Very High	2	7%	17	57%
52–63	High	11	36%	13	43%
40–51	Moderate	17	57%	0	0%
28–39	Low	0	0%	0	0%
15–27	Very Low	0	0%	0	0%

Based on the questionnaire results, there was a clear shift in the categories of students' learning motivation before and after the use of Wordwall-based educational games. Table 5 illustrates the frequency distribution and percentage of students' learning motivation levels. The following Figure 1 presents a diagram showing the percentage distribution of students' learning motivation.

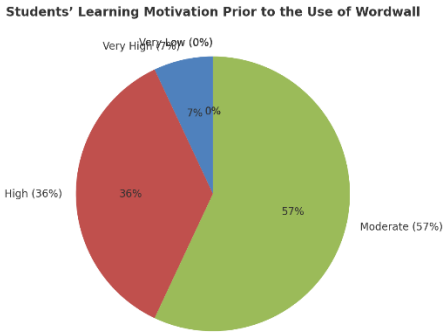

Figure 1. Students' Learning Motivation Prior to the Use of Wordwall

Figure 1 illustrates that prior to the implementation of Wordwall-based educational games, most students were categorized as moderate (57%), followed by high (36%) and very high (7%). No students were classified in the low or very low categories.

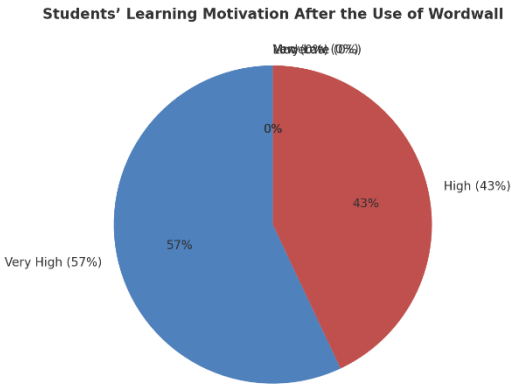

Figure 2 Students' Learning Motivation After to the Use of Wordwall

Figure 2 illustrates that after the use of Wordwall-based educational games, students' learning motivation increased, with 43% of students categorized as high and 57% categorized as very high. No students were found in the moderate, low, or very low categories after the implementation of Wordwall. Nevertheless, descriptive analysis alone is not sufficient to

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confirm the effect of Wordwall on students' motivation. Therefore, inferential statistical analysis was conducted to obtain more valid results.

Table 6. Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest	0.121	30	0.200*	0.972	30	0.591
Posttest	0.140	30	0.135	0.973	30	0.613

*Lilliefors Significance Correction

As shown in Table 6, the normality test was conducted using the Shapiro-Wilk statistic for both pretest and posttest data. The results indicate that the significance values were greater than 0.05, suggesting that both datasets were normally distributed and thus met the assumptions required for parametric testing.

Table 7. Paired Samples Test

Paired Samples Test

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Pretest - Posttest	-12.500	5.912	1.079	-14.707	-10.293	-11.581	29	.000

Based on Table 7, the significance value (2-tailed) for the pretest and posttest comparison was 0.000, which is less than 0.05. Therefore, H_0 was rejected and H_1 was accepted, indicating a significant difference in students' learning motivation before and after the use of Wordwall-based educational games in mathematics learning. These results demonstrate that Wordwall had a significant positive effect on the learning motivation of fourth-grade students

Discussion

The findings of this study demonstrate that the use of Wordwall-based educational games significantly enhanced students' learning motivation in mathematics, particularly in mixed arithmetic operations. Prior to the intervention, most students were categorized as having moderate motivation; however, following the implementation of Wordwall, all students shifted into the high and very high motivation categories. This transformation indicates that game-based learning approaches can create a more engaging, challenging, and interactive learning atmosphere, thereby increasing students' emotional and cognitive engagement with the subject matter.

The learning activity conducted through the "Open the Box" feature in Wordwall provided a different experience compared to conventional teaching methods. This feature allowed the learning process to be tailored to students' diverse needs, including learning styles, levels of understanding, and learning interests (Yustin et al., 2025). The randomization and visual elements of the game stimulated students' curiosity and encouraged their active participation in solving problems. Moreover, the appealing digital interface and the challenges embedded in each question strengthened students' focus and concentration. In line with Keller's ARCS model (Attention, Relevance, Confidence, Satisfaction), this approach successfully fulfilled the attention and satisfaction components, which are essential for fostering learning motivation.

These results are consistent with the study of Salsabila et al. (2023), which found that the use of Wordwall increased students' enthusiasm and active participation in mathematics learning. Similarly, Batubara et al. (2024) reported that Wordwall positively influenced students' motivation by presenting content in a more attractive and interactive manner. Indriyani et al. (2024) also emphasized that digital game-based learning is effective in significantly improving both motivation and conceptual understanding in mathematics. The consistency of these findings suggests that Wordwall not only impacts cognitive learning outcomes but also strengthens the affective aspects of the learning process. Nevertheless, the effectiveness of Wordwall is also influenced by supporting factors such as teachers' readiness in preparing questions, their technological competence, and the availability of classroom facilities. Supporting this argument, Suryana et al. (2024) also revealed that the use of Wordwall significantly improved students' learning motivation, particularly in terms of active participation and interest in the subject matter. These converging findings reinforce the view that the integration of Wordwall into classroom practice is an effective strategy for creating more meaningful and motivating learning experiences.

The observed increase in learning motivation is further supported by the statistical results of the paired-sample t-test, which revealed a significant difference between pretest and posttest scores ($p < 0.05$). This confirms that the use of Wordwall had a real effect on students' motivation. Pedagogically, this strengthens the argument that employing interactive learning technologies can serve as an effective alternative strategy for enhancing students' learning experiences (Ayalon & Wilkie, 2020; Stylianides & Stylianides, 2022; Yang et al., 2022). More broadly, these findings provide empirical contributions to the development of learning media that address not only cognitive achievement but also students' affective engagement in the learning process.

The practical implication of this study is that Wordwall can be integrated as an innovative instructional tool to foster student motivation in mathematics classrooms. Teachers can utilize its features to create varied and engaging activities that encourage active participation, thus reducing the perception of mathematics as a difficult and monotonous subject. Theoretically, the findings contribute to the growing body of literature on game-based learning by providing empirical evidence of its effectiveness in enhancing both the cognitive and affective domains. Furthermore, this study supports the ARCS motivation framework by illustrating how interactive digital tools can fulfill key motivational components such as attention and satisfaction.

Despite its promising results, this study has certain limitations. First, it employed a pre-experimental design without a control group, which restricts the generalizability of the findings. Second, the sample size was limited to one class of 30 students, making the results context-specific. Third, the study focused primarily on motivation and did not directly measure long-term effects on cognitive learning outcomes. Future research should employ more robust experimental designs with larger and more diverse samples, as well as explore the sustained impact of Wordwall on both motivation and academic achievement

Conclusion

This study concludes that the use of Wordwall-based educational games has a significant positive impact on students' learning motivation in mathematics, particularly in the topic of mixed arithmetic operations. The findings revealed a substantial shift in motivation categories, where students initially classified as moderate moved to higher levels of motivation, namely high and very high, after the intervention. Statistical analysis using a paired-sample t-test confirmed that this improvement was significant ($p < 0.05$), indicating that Wordwall

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effectively fosters students' motivation in mathematics learning. The results highlight the potential of game-based learning platforms, such as Wordwall, to transform classroom dynamics by creating more engaging, interactive, and student-centered learning environments. These findings also emphasize the importance of integrating technology to not only enhance cognitive outcomes but also strengthen students' affective engagement in the learning process. In practice, Wordwall can serve as an innovative teaching strategy for mathematics educators, offering varied and enjoyable learning activities that encourage participation and reduce students' negative perceptions of the subject. Nonetheless, the study acknowledges its limitations in terms of design and sample size, suggesting the need for further research with larger, more diverse populations and more rigorous methodologies to explore the long-term effects of Wordwall on both motivation and academic performance.

Conflict of Interest

The authors declare that there is no conflict of interest.

Author Contributions

I.F. conceptualized the research idea, designed the study, collected the data, and drafted the manuscript. B. supervised the research process, provided guidance on methodology, contributed to data analysis, and critically revised the manuscript. Both authors discussed the results together and approved the final version of the paper. The percentage contributions to the conceptualization, drafting, and revision of this manuscript are as follows: I.F.: 70% and B.: 30%.

Data Availability Statement

The authors state that the data supporting the findings of this study are available from the corresponding author, [I.F.], upon reasonable request.

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