

# Wordwall-Assisted Gamification: Improving Mathematics Learning Outcomes Through Strengthening Motivation and Learning Engagement

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**ABSTRACT.** This study aims to examine the impact of implementing a gamification-based learning model supported by the Wordwall platform on the learning outcomes of seventh-grade students at MTsN 1 Medan, particularly in algebraic factorization. Employing a quasi-experimental method with a pretest–posttest control-group Design, the sample was selected via cluster random sampling from 11 existing classes, with class VII-H designated as the experimental group and class VII-I as the control group. The analysis revealed that this model significantly improved students' learning outcomes, as evidenced by a t-test with a p-value below 0.05, indicating a meaningful difference between the two groups. Qualitative interviews further revealed that Wordwall effectively enhanced students' motivation, engagement, and active participation, demonstrating that the model's implementation has a positive, significant impact on their academic achievement.

**Keywords:** algebraic factorization; gamification; learning outcomes; wordwall

**ABSTRAK.** Penelitian ini bertujuan untuk mengkaji dampak penerapan model pembelajaran gamifikasi yang didukung platform Wordwall terhadap hasil belajar siswa kelas VII di MTsN 1 Medan, khususnya pada materi faktorisasi aljabar. Penelitian ini menggunakan metode kuasi-eksperimen dengan desain pretest-posttest control group. Sampel dipilih melalui teknik cluster random sampling dari sebelas kelas yang ada, yaitu kelas VII-H sebagai kelompok eksperimen dan VII-I sebagai kelompok kontrol. Analisis menunjukkan bahwa model ini secara signifikan meningkatkan hasil belajar siswa, dengan uji-t menghasilkan nilai signifikansi di bawah 0,05 yang menandai perbedaan bermakna antara kedua kelompok. Wawancara kualitatif juga mengungkapkan bahwa Wordwall mampu membangkitkan motivasi, keterlibatan, dan partisipasi aktif siswa, sehingga penerapan model ini terbukti memberikan dampak positif dan signifikan pada pencapaian akademik mereka.

**Kata kunci:** faktorisasi aljabar; gamifikasi; hasil belajar; wordwall

## INTRODUCTION

Entering the 21st century, the world of education faces a significant challenge: rapid developments in information and communication technology. The 4.0 industrial revolution, characterized by digitalization in almost all aspects of life, demands innovation in the education system. The teaching and learning process can no longer rely solely on conventional methods; it must be adapted to the demands of the times, which prioritize critical thinking, collaboration, communication, and creativity. Reflecting on the results of the 2022 Programme for International Student Assessment (PISA), Indonesian students' mathematics scores reached 366 points, down from 379 in PISA 2018, and below the global average of around 472 points, highlighting a persistent challenge in mathematics literacy among 15-year-old learners; this performance, which remains significantly below the OECD mean and has continued to decline over successive assessment cycles,

underscores the urgent need for systemic educational reforms that foster deeper conceptual understanding and equitable learning opportunities for all students in Indonesia (OECD, 2023).

Mathematics is a fundamental discipline that plays a crucial role in shaping students' thinking, particularly by fostering reasoning skills and the ability to adapt to advances in science and technology (Rahman, dkk., 2025). According to Ilmi dkk. (2025), mathematics is one of the sciences inseparable from everyday human life, yet mathematics learning still faces many problems, including low student learning outcomes. Furthermore, Rahman dkk. (2025) stated that mathematics plays a fundamental role in developing students' ways of thinking, particularly in fostering logical reasoning and problem-solving abilities through meaningful learning experiences. However, mathematics is one of the least favorite subjects because it is often perceived as scary, tedious, and challenging to learn. Student learning outcomes in mathematics tend to be low, especially in complex subjects such as algebra and factorization. These low learning outcomes are caused by several factors, including predominantly lecture-based teaching methods, limited use of innovative learning media, and a lack of active student involvement in the learning process. Lestari dkk. (2024) state that learning outcomes are not only determined by mastery of concepts but also by students' active involvement in tasks, discussions, and classroom interactions. Nahdania and Ain (2024) explain that monotonous teaching methods and teacher-centered instruction tend to make students feel bored, thereby reducing their motivation and engagement in learning mathematics. If the learning process is monotonous, students' motivation will decrease, ultimately affecting their academic achievement.

Based on observations during the School Field Introduction (PLP) III activity at MTs Al Ittihadiyah, it was found that the mathematics learning process is still dominated by a conventional approach, in which teachers are the center of information and students are passive participants in learning activities. Learning activities focus more on one-way delivery of material through lectures and routine exercises, so that opportunities for students to think critically, collaborate, or express their opinions are still limited. This condition leads to low student engagement in the learning process and to learning outcomes that have not reached optimal levels. In addition, some students lack motivation and confidence in solving mathematical problems, which has implications for low academic achievement in specific subjects, including algebraic factorization.

The results of the observation are also consistent with the reflective findings during the observation at MTs Negeri 1 Medan, the study's location. In the implementation of mathematics learning, activities remain teacher-centered, and student participation is relatively low. Most students appear less enthusiastic about participating in learning activities and rarely engage in class interactions or discussions. The use of technology-based learning media is still limited, so the learning atmosphere tends to be monotonous and fails to capture students' attention. This situation shows that learning has not thoroughly fostered active student involvement and has not provided sufficient space to develop critical thinking skills and independent problem-solving abilities.

The issue of low confidence and motivation in learning mathematics is also highlighted by Sardin dkk. (2025), who emphasize that students' self-efficacy plays a crucial role in determining their engagement, persistence, and performance in mathematics learning. Nahdania and Ain (2024) highlight that students' difficulties in understanding mathematical concepts stem from various internal and external factors, which ultimately contribute to low mathematics learning outcomes. This condition further worsens students' learning outcomes because their involvement in learning is minimal. Sardin dkk. also note that monotonous learning processes make students less enthusiastic and less active during mathematics lessons. Therefore, learning strategies are needed that can minimize anxiety while encouraging students to participate more actively.

One subject that plays an important role and poses a challenge for junior high school students is algebraic factorization. This subject is studied in seventh grade and is a prerequisite for understanding advanced topics, such as quadratic equations and algebraic simplification. However, in reality, many students have difficulty learning this subject, both in understanding the concepts and in solving problems. This is reinforced by research conducted by Janani & Nurcahyo (2023), which shows that learning algebraic factorization still requires innovative media to make it easier for

students to understand. Therefore, the selection of algebraic factorization material in this study is very relevant for further study.

One approach increasingly used to address this challenge is gamification. Kapp (2012) explains that gamification is an instructional approach that utilizes game mechanics to create more engaging and meaningful learning experiences, emphasizing learner engagement, narrative elements, autonomy, and a sense of purpose within the learning process. Wangi dkk. (2022) also explain that gamification has been proven to increase student motivation by creating a more engaging and challenging learning environment. This approach not only makes learning fun but also provides a meaningful learning experience. Kapp, Blair, and Mesch (2014) argue that gamification plays a significant role in enhancing learner motivation, as evidenced by its successful application in high-stakes test preparation, empirical research on game-based achievements that foster self-efficacy and performance, and scholarly analyses demonstrating how game elements effectively support motivational processes in learning contexts. Students do not simply receive information, but are encouraged to interact, compete, and collaborate with their classmates. Gusmana and Amir (2024) stated that several studies show that mathematics often feels abstract to students, so learning media are needed that can present concepts more concretely and interestingly. In line with Jurani and Nuh (2025), who explain that game-based learning approaches offer a fun and interactive way to deepen understanding of mathematics. Ilmi dkk. (2025) also note that game-based learning can encourage student engagement in learning and foster an independent learning attitude.

The integration of gamification with mobile learning technology enhances its effectiveness. Mobile learning allows students to access learning materials anytime and anywhere using devices such as smartphones or tablets (Utami & Riadi, 2022). Thus, learning is no longer limited to specific times and places. The combination of gamification and mobile learning provides flexibility and additional motivation for students to learn independently or in groups.

In this context, the Wordwall application is an up-and-coming medium. Wordwall provides a variety of educational game templates for teachers to Design interactive learning activities, including quizzes, crosswords, random wheels, and matching games. Yuliyani and Mahariah (2025) explain that using Wordwall multimedia creates a more interactive learning experience, helping students stay engaged and reducing boredom during the learning process. Additionally, Wordwall is free to use, easily accessible, and visually appealing, making it suitable for both elementary and secondary schools.

Various previous studies support Wordwall's effectiveness in learning. Yunita and Mustika (2025) demonstrated that using Wordwall as an interactive learning medium significantly increased elementary school students' interest in learning, particularly in understanding abstract science material such as the circulatory system. This finding is consistent with Yuliyani's (2025) study, which found that integrating Wordwall-based learning activities can enhance students' engagement and positively affect their mathematics learning outcomes through interactive, game-oriented features. Similarly, Aidah & Nurafni (2022) demonstrated the effectiveness of Wordwall in science learning, increasing student participation and facilitating understanding of scientific concepts. These research results indicate that Wordwall can address the challenges of low interest and learning outcomes in various subjects.

However, Wordwall also has limitations. Irnawati dkk. (2024) argue that integrating gamification-based digital learning platforms can foster students' learning motivation by creating a more enjoyable and engaging learning environment, particularly in mathematics classrooms. However, these weaknesses do not diminish Wordwall's primary benefit of creating interactive and enjoyable learning. In fact, these limitations can be overcome with adequate teacher preparation, for example, by ensuring that an internet connection is available and by choosing a display Design suitable for classroom conditions.

Although previous studies have reported the effectiveness of Wordwall and gamification in mathematics learning, most remain general and have not specifically examined the implementation of Wordwall-assisted gamification in algebraic factorization at the junior secondary level. Moreover,

existing research tends to position Wordwall merely as a learning medium rather than as an integral component of a gamified instructional model. Studies that connect quantitative learning outcomes with students' engagement and responses as supporting evidence are also limited. Therefore, this study addresses these gaps by investigating the effect of Wordwall-assisted gamification on students' learning outcomes in algebraic factorization.

## METHODS

This study employed a quasi-experimental Design using a pretest–posttest control group Design, mainly because the class composition had been permanently determined before the study began. We selected the sample through cluster random sampling from eleven seventh-grade classes at MTsN 1 Medan. Cluster *random* sampling is a probability sampling method in which the population is divided into several groups or clusters that are internally homogeneous but externally heterogeneous. A subset of clusters is then randomly selected as the research sample (Sari, Safitri, & Anggraini, 2019). After random selection, Class VII-H became the experimental group, while Class VII-I became the control group. Students in the experimental group received lessons through a gamification model on the Wordwall platform, while the control group continued using traditional teaching methods.

The research instrument was a mathematics learning outcomes test consisting of 7 essay items, developed from a test blueprint aligned with algebraic factorization content. The achievement indicators assessed students' abilities to write the factorization of simple algebraic expressions, explain the factorization process of trinomials, factor quadratic expressions of the form, solve factorization problems using the grouping method, apply factorization in contextual word problems, select and implement appropriate factorization methods for mixed problems, and construct and factor quadratic expressions independently. Each item was scored on a scale of 0–4, resulting in a total score range of 0–28. Instrument validity was examined using the Pearson Product–Moment correlation, while reliability was assessed using Cronbach's Alpha coefficient.

Research data were analyzed using descriptive statistics to characterize students' pretest and posttest scores. Prior to hypothesis testing, statistical assumption tests were conducted, including the Kolmogorov–Smirnov test for normality and Levene's test for homogeneity. Hypothesis testing was performed using an independent samples t-test to examine differences in learning outcomes between the experimental and control groups. Students' learning improvement was analyzed using N-Gain score calculations. In addition, limited interviews with six students from the experimental group were conducted to provide supporting data to strengthen the interpretation of the quantitative findings on the impact of Wordwall-assisted gamification.

## RESULT AND DISCUSSION

We began our data analysis by presenting the pretest and posttest scores of both the experimental and control groups. The aim here was to assess how students' understanding of the basic concepts of algebraic factorization improved after using the gamification model with Wordwall support. Before the intervention, both groups had fairly balanced initial skills. This can be seen from the pretest results: the experimental group had an average of 10.45 with a standard deviation of 3.74, while the control group had an average of 9.74 with a standard deviation of 5.06. Statistically, there was no significant difference in their initial abilities, meaning that both groups started from a similar position. See the table below for the pretest scores:

Table 1. *Pretest Data*

<i>Pre-test Data</i>	Experimental Class	Control Class
Number of students (N)	31	31
Mean	10.45	9.74

Median	10	10
Mode	6	10
Standard deviation	3.74	5.06
Lowest value	6	1
Highest value	17	18

After the learning process, which included different treatments for each group, the posttest results showed significant improvement, especially in the experimental class. The average posttest score for the experimental class increased to 23.81, with a standard deviation of 3.89, while the control class only achieved an average of 16.97 with a standard deviation of 5.14. This difference in increase confirms that the Wordwall-assisted gamification learning model can improve student learning outcomes more effectively than conventional methods. The increase in scores in the experimental class was also accompanied by a narrowing of the score range, which indicates a more even increase in understanding among students. The following table shows the posttest results for the experimental and control classes:

**Table 2. Posttest Data**

<i>Posttest Data</i>	<b>Experimental Class</b>	<b>Control Class</b>
Number of students (N)	31	31
Mean	23.81	16.97
Median	25	16
Mode	25	17
Standard deviation	3.89	5.14
Lowest value	14	8
Highest value	28	28

Overall, the results of the study indicate that the integration of game-based elements such as challenges, rewards, and competitive components through the use of Wordwall has a positive impact on student motivation and engagement in the learning process. The significant increase between pretest and posttest scores shows that the gamification approach is not only effective in improving cognitive learning outcomes but also in encouraging active student participation in classroom activities, ultimately contributing to improved academic achievement. Furthermore, statistical assumption tests, including tests of normality and homogeneity, were conducted.

Both tests were conducted to verify that the data met the assumptions required for parametric analysis, ensuring that the inferential test results could be interpreted with validity and reliability.

**Table 3. N-Gain Score Calculation Results for the Experimental Class and Control Class**

<b>Class</b>	<i>Pre-test Average</i>	<i>Posttest Mean</i>	<b>Maximum Score</b>	<i>N-Gain</i>	<b>Category</b>
Experiment	10.45	23.81	28	0.76	High
Control	9.74	16.97	28	0.40	Moderate

After reviewing the pretest and posttest data, an analysis of learning improvement was conducted using the N-Gain Score, which measures the effectiveness of the treatment by comparing pretest and posttest results in the experimental and control classes.

Based on Table 3 above, the average pretest score in the experimental class was 10.45, rising to 23.81 after learning with the Wordwall-assisted gamification model. Meanwhile, in the control class, the average pretest score was 9.74, increasing to 16.97 after conventional learning. Based on the Normalized Gain calculation, the average N-Gain value for the experimental class was 0.76, which is in the high category. In contrast, the control class obtained a value of 0.40, which is in the moderate category.

The results show that student learning outcomes in the experimental class increased more than in the control class. This means that the application of the Wordwall-assisted gamification learning model improved student learning outcomes more effectively than conventional learning. This improvement was due to the use of gamification elements such as points, leaderboards, and

rewards that encouraged active engagement and motivation among students during the learning process.

**Table 4. Normality Test Results**

Statistics	Control Class <i>Pretest</i>	Experimental Class <i>Pretest</i>	<i>Posttest</i> Control Class	<i>Posttest of the</i> Experimental Class
N	31	31	31	31
<i>D<sub>Tabel</sub></i>	0.224	0.224	0.224	0.224
<i>D<sub>Max</sub></i>	0.125	0.131	0.143	0.140
Conclusion	Normal	Normal	Normal	Normal

Based on the data in Table 4, the Kolmogorov-Smirnov test values for the control class pretest were 0.125, and for the experimental class pretest were 0.131. This indicates that the *D<sub>Max</sub>* test values for the control and experimental classes in the pretest are smaller than *D<sub>Tabel</sub>*=0.224, so the control and experimental class pretest data are typically distributed. Furthermore, the *D<sub>Max</sub>* test value for the control class posttest is 0.143, and for the experimental class posttest is 0.140. This also shows that the *D<sub>Max</sub>* test values for the control class posttest and the experimental class posttest are smaller than *D<sub>Tabel</sub>* = 0.224, so it can be concluded that the control class posttest and the experimental class posttest data are typically distributed.

**Table 5. Homogeneity Test Results**

Statistics	<i>Pretest</i>	<i>Posttest</i>
N	31	31
$\alpha$	0.05	0.05
Sig (2-tailed)	0.082	0.161
Conclusion	Homogeneous	Homogeneous

Table 5 shows that the significance values for the pretest homogeneity test (0.082) and the posttest homogeneity test (0.161) are not significant. This indicates that the significance value of the data is greater than the significance level  $\alpha = 0.05$ , so it can be concluded that both the pretest and posttest data have homogeneous variance.

After confirming that the data fulfilled the assumptions of normality and homogeneity, the analysis proceeded to the inferential stage to evaluate the formulated research hypotheses. This phase aimed to determine the extent to which the Wordwall-assisted gamification model influenced students' academic achievement in algebraic factorization. Several statistical tests were employed, including an independent-samples t-test to compare the performance of the experimental and control groups, and a paired-samples t-test to examine improvements within each group from pretest to posttest. Additionally, Pearson's correlation analysis was utilized to identify the relationship between students' initial abilities and their final learning outcomes in the experimental class. Collectively, the results of these inferential analyses provide substantial empirical support for the effectiveness of the Wordwall-assisted gamification model in enhancing students' learning outcomes, both statistically and pedagogically.

**Table 6. Independent Sample t-Test Results**

Statistical Component	Value
N	31
$\alpha$	0.05
Sig(2-tailed)	< 0.0001
Conclusion	There is an effect

Based on Table 6, the data used from the independent sample t-test results is equal variance assumed with a Sig (2-tailed) value of 0.00000017 and an independent sample t-test criterion of 0.05, which shows that the Sig (2-tailed) value is smaller, so it can be concluded that  $H_0$  is rejected and  $H_1$  is accepted. This indicates that the Wordwall-assisted gamification learning model affects student learning outcomes.

Based on this study's findings, the use of gamification models via Wordwall significantly improved students' scores in algebraic factorization. The experimental group's average score increased significantly from the pretest to the posttest, whereas the control group's average score remained unchanged. These findings indicate that incorporating game elements such as challenges, rewards, and competitions can enrich the learning environment by increasing motivation and engagement, thereby increasing students' interest in understanding the subject matter. As a result, gamified learning not only supports cognitive development but also fosters emotional and social engagement throughout the learning process.

Conceptually, these findings align with Gusmana and Amir (2024), who emphasize that well-designed, engaging learning media can enhance students' motivation to learn, which, in turn, positively influences their conceptual understanding and mathematics learning outcomes. The findings of this study are also consistent with Triandini, Saragih, & Siregar (2024), who reported that the implementation of learning supported by interactive media can enhance students' mathematics learning outcomes, particularly in systematically solving algebraic problems. In the context of this study, the integration of Wordwall includes game-based components that provide instant feedback, helping students feel recognized and motivated to continue striving for optimal achievement. These elements create an active learning atmosphere in which students are not merely passive recipients of information, but actively participate in solving algebraic factorization problems.

The results of the inferential analysis show a clear statistical difference in performance between the experimental and control groups. This indicates that the difference we see is not merely random luck, but truly reflects the real effect of the gamification learning model we used. These findings align with the study by Irnawati dkk. (2024), which demonstrates that implementing gamification in mathematics learning can significantly enhance students' motivation and engagement. Mathew and Nair (2024) also argue that implementing gamification can foster intrinsic motivation, thereby significantly enhancing learning outcomes. Marczewski (2023) also argues that the implementation of game elements in learning aims to enhance learner engagement, in line with the core objectives of gamification: creating more engaging and meaningful learning experiences. Therefore, gamification serves as an effective bridge between technology and pedagogy, facilitating a deeper understanding of abstract mathematical concepts.

In addition, the improvement in learning outcomes observed in the experimental group shows that the gamification approach is efficient when applied to procedural topics such as algebraic factorization. The challenges embedded in the game allow students to engage indirectly in repetitive, enjoyable practice of the steps of factorization. This repetitive process strengthens memory retention and facilitates a deeper understanding of factorization patterns. These findings are consistent with the constructivist perspective, which states that meaningful learning occurs when learners actively construct their understanding through direct engagement and experience.

Another factor contributing to the effectiveness of gamification is the provision of quick and relevant feedback. On Wordwall, each answer is given an immediate correct/incorrect response, allowing students to correct their mistakes immediately. This mechanism accelerates the learning reflection process and helps students adjust their thinking strategies. According to cognitive learning theory, immediate feedback after a student's response will strengthen the correct stimulus-response relationship and minimize conceptual errors. Based on the interview results, it was also found that the gamified learning model supported by Wordwall can increase student motivation, make learning more interesting, and encourage their activity and engagement. This is due to gamification elements such as points, badges, leaderboards, avatars, and levels that foster a spirit of competition and improve students' critical understanding in learning.

However, implementing gamification is not entirely free of challenges. Some students show excessive enthusiasm for the competitive aspects of the game, sometimes neglecting conceptual understanding. Therefore, teachers need to balance the goals of entertainment and learning by directing students' focus on conceptual understanding, not just scores. With proper management,

gamification can be an effective way to foster enthusiasm for learning without sacrificing depth of understanding.

Overall, the results of this study reinforce the view that mathematics learning can be improved through innovative models that combine digital technology with modern pedagogical approaches. The gamification learning model supported by Wordwall has been proven to transform classroom dynamics into a more lively, interactive environment. The implication of this study is the need for teacher training in designing targeted, meaningful gamification activities that can be applied sustainably in mathematics learning in secondary schools.

Furthermore, Wordwall's effectiveness lies not only in its visual appeal but also in its ability to break down the complexity of algebraic factorization into manageable, bite-sized cognitive challenges. By transforming repetitive practice into an engaging "cognitive quest," students tend to exhibit greater persistence when facing complex problems. This suggests that the synergy between sound instructional Design and gamification elements can significantly reduce math anxiety—a common barrier for secondary students—while fostering a more resilient mindset toward mastering abstract mathematical structures.

Moreover, these results provide educators with a strategic roadmap for the importance of digital adaptation in modern curricula. The integration of gamified features such as leaderboards and badges creates a transparent learning ecosystem where students can monitor their progress in real time, encouraging self-regulated learning. Moving forward, the success of this model implies that gamification should not be viewed as a mere supplementary tool, but as a core pedagogical strategy capable of transforming passive classrooms into dynamic hubs of active inquiry and deep conceptual mastery across various mathematical domains.

## CONCLUSION

Based on the research and discussion, it can be concluded that mathematics learning in algebraic factorization shows a significant difference between the Wordwall-assisted gamification model and the conventional method. In the control class, which was taught using the conventional approach, the average pretest score of 9.74 increased to 16.97 on the posttest, with an N-Gain score of 0.40, which is classified as moderate. This shows that the conventional method remains capable of improving learning outcomes, even though student engagement in the learning process is not yet optimal due to the teacher's dominant role. In contrast, in the experimental class that applied the Wordwall-assisted gamification learning model, the increase was much more significant: the average pretest score of 10.45 increased to 23.81 on the posttest, with an N-Gain of 0.76, which is classified as high. These results indicate that the integration of gamification elements such as challenges, rewards, competition, and feedback can create an enjoyable learning experience, increase students' intrinsic motivation, and deepen their understanding of the concept of algebraic form factorization. Based on the t-test results ( $p\text{-value} = 0.000 < 0.05$ ), it can be concluded that the Wordwall-assisted gamification learning model has a positive and significant effect on improving the learning outcomes of seventh-grade students, making it an effective alternative for developing more interactive and meaningful mathematics learning.

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