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The Effect of Wordwall-Based Interactive Learning Media and Learning Motivation on High School Students' Informatics Learning Outcomes

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Abstract
The rapid development of digital technology requires innovative learning approaches that improve student engagement and learning outcomes, particularly in informatics education. However, Classroom instruction is still frequently dominated by conventional methods that limit student participation and reduce conceptual understanding. This study aimed to analyse the effect of Wordwall-based interactive learning media and learning motivation on senior high school students' informatics learning outcomes. This study employed a quantitative, quasi-experimental design with a 2×2 factorial structure. The research involved 60 tenth-grade students at SMAN 1 Siberut Utara selected through purposive sampling. Students were divided into an experimental class using Wordwall and a control class using conventional learning media. Data were collected through learning outcome tests and motivation questionnaires, and analysed using descriptive statistics and a Two-Way ANOVA. The findings showed that students taught using Wordwall achieved higher learning outcomes than those taught conventionally. The highest posttest mean score was obtained by students with high learning motivation in the Wordwall group (91.42), while the lowest score was found in students with low motivation in the conventional class (50.81). Statistical analysis demonstrated that learning media significantly affected learning outcomes ($F = 38.32 > 4.013$), learning motivation significantly affected learning outcomes ($F = 108.84 > 4.013$), and there was a significant interaction between Wordwall and learning motivation on students' learning outcomes ($F = 5.58 > 4.013$). The study concludes that Wordwall-based interactive learning effectively improves informatics learning outcomes and creates a more engaging and meaningful learning environment aligned with 21st-century educational demands.

Keywords: Gamified Learning; Informatics Education; Learning Motivation; Learning Outcomes; Wordwall.

INTRODUCTION

Learning in schools today is inseparable from the development of digital technology, which is increasingly woven into students' lives. The current generation of students grows up in a technology-rich environment, leading to more visual, interactive, and dynamic learning characteristics (Mandal et al., 2022; Setyawan & Purbohadi, 2025). This situation demands that teachers present learning that captures students' attention and actively engages them. In informatics subjects, the learning process is not only focused on delivering material but also on developing logical, computational, and problem-solving skills (Putri & Prasetyo, 2023; Chen & Nguyen, 2024). Therefore, informatics learning requires an innovative approach to enable students to understand concepts more meaningfully (Mariono et al., 2021). Providing learning experiences that are relevant to students' needs is a major challenge in current learning practices (Zhong, 2023).

However, the implementation of informatics education in academic institutions continues to face numerous challenges, particularly the limited application of pedagogical strategies. The educational experience is largely traditional, characterised by lectures and assignments that lack engaging student interaction. This contributes to reduced student engagement and a suboptimal understanding of informatics principles. Abstract content often leads to cognitive fatigue and diminishes student enthusiasm for learning (Kashlot, 2025). The impact of this phenomenon is evident in low student participation throughout the educational experience, underscoring the need for more dynamic and innovative approaches to instructional media (Guan et al., 2025).

Interactive learning media utilising digital technology are increasingly recognised as a viable alternative to enhance the quality of educational experiences. A well-known, easily implemented medium in this context is Wordwall, which serves as a gamification-oriented learning platform (Suryani et al., 2026). Wordwall empowers educators to develop learning activities that take the form of educational games, interactive quizzes, and digital assessments. The available interactive functions can increase student engagement through enjoyable learning experiences (Velasco & Teixeira Nakamoto, 2023). Empirical evidence shows that game-based learning paradigms significantly increase student attention and active engagement. Therefore, Wordwall integration holds great promise for enhancing the efficacy of informatics instruction in secondary education institutions (Alifa et al., 2024).

In addition to educational media, intrinsic factors associated with students also significantly contribute to academic success. Learning motivation is recognised as a psychological drive that influences the intensity and persistence of students' educational efforts (Pasupuleti et al., 2025). Students who exhibit high levels of motivation tend to demonstrate resilience, curiosity, and proactive engagement in the educational process. Conversely, reduced learning motivation can hinder the achievement of optimal educational outcomes. Motivation is a fundamental catalyst for achieving educational goals. Consequently, the interaction between interactive educational media and learning motivation is an important dimension that requires empirical investigation (Ding & Yu, 2024; Fitrah et al., 2025).

Previous studies have shown that interactive digital media and gamification can improve student engagement, motivation, and academic achievement (Chen & Nguyen, 2024; Zawacki-Richter et al., 2024). However, most existing studies have examined the influence of learning media and learning motivation separately, with limited attention to their combined effects, particularly in informatics education. In addition, research specifically investigating the use of Wordwall-based gamified learning for computer system materials at the senior high school level remains limited. This gap indicates the need for a more comprehensive study examining how interactive Wordwall media and student learning motivation interact in influencing learning outcomes. Therefore, the novelty of this study lies in integrating gamified Wordwall learning media and learning motivation variables into informatics education, especially in the context of computer system learning. This study is expected to contribute not only to the development of technology-based learning strategies but also to provide empirical evidence regarding the importance of combining interactive media and motivational factors to improve student learning outcomes.

Given the identified challenges and research gaps, this investigation seeks to examine the impact of Wordwall-based interactive learning media and student motivation on the academic performance of high school students in informatics. This investigation is anticipated to provide theoretical advancements in the field of integrated pedagogy of digital technology and educational gamification. Furthermore, this research is poised to offer educators practical insights for creating innovative and effective informatics curricula. The findings of this study can serve as a basis for informed decision-making regarding the implementation of digital learning

resources in educational institutions. The implementation of interactive learning methodologies is anticipated to sustainably enhance student motivation and educational outcomes. Consequently, this research is significant for addressing the demands of 21st-century education (Tiberius & Weyland, 2024; Horváth et al., 2025).

METHODS

This study employed a quantitative approach using a quasi-experimental method with a 2×2 factorial design. The research aimed to examine the effect of Wordwall-based interactive learning media and students' learning motivation on learning outcomes in the Computer Systems topic of Informatics education. The independent variables consisted of learning media (Wordwall-based interactive media and conventional media) and learning motivation (high and low), while the dependent variable was students' learning outcomes. The study was conducted at SMAN 1 Siberut Utara during the even semester of the 2025/2026 academic year. The population comprised all Grade X students totaling 129 learners, and the sample was selected using purposive sampling, assigning class X E_1 as the experimental group and class X E_2 as the control group, resulting in 60 participants.

To ensure internal validity, both experimental and control groups were administered a pretest to examine baseline equivalence prior to treatment implementation. The learning duration, instructional objectives, teacher involvement, and assessment procedures were kept consistent across groups. Treatment fidelity was maintained through structured observation to ensure that the Wordwall-based learning activities were implemented according to the planned instructional procedures.

Data were collected using achievement tests and a learning motivation questionnaire. The achievement test consisted of pretest and posttest instruments developed based on cognitive learning outcome indicators in the Computer Systems material, while the motivation questionnaire was constructed using indicators of learning motivation covering attention, relevance, confidence, and satisfaction aspects. The instruments were developed through stages of blueprint preparation, expert validation, revision, and field testing. Content validity was assessed through expert judgment, while empirical validity was analyzed using item correlation analysis. Instrument reliability was tested using Cronbach's Alpha to ensure consistency and accuracy of measurement before implementation in the experimental study.

Table 1. 2×2 Factorial Research Design

Motivation to learn	Wordwall (A1)	Conventional (A2)
High (B1)	A1B1	A2B1
Low (B2)	A1B2	A2B2

Based on the methodological framework depicted in Table 1, the study categorized participants into two distinct pedagogical treatment modalities and two motivational engagement classifications. The initial cohort participated in instructional sessions using interactive media via Wordwall, while the subsequent cohort engaged with traditional pedagogical resources. Next, students were grouped according to their motivational level, specifically categorized as high or low. This 2x2 factorial design enabled the researcher to examine the effects of each variable and the interaction between instructional media and motivational level on student educational outcomes in informatics. Through this methodological approach, the investigation's findings are anticipated to provide a more holistic understanding of Wordwall's efficacy in improving student performance in informatics disciplines.

Table 2. Research Population

Class	Number of Students
X E_1	33
X E_2	35

X E_3	36
X E_4	25
Total	**129**

The research group consisted of all 10th-grade students at SMAN 1 North Siberut, totaling 129 individuals, distributed across four study groups. All educational environments exhibited relatively uniform learning characteristics, as they adhered to a standard curriculum, used identical materials, and involved the same subject instructors. From this cohort, the researchers identified two classes to serve as the research sample, using a purposive sampling approach based on equivalence in student abilities and classroom conditions. The sample selection was conducted to secure representative data for the study, thus ensuring that the findings could more accurately describe the impact of Wordwall media utilization and learning motivation on students' informatics academic performance.

Table 3. Research Population

Class	Treatment	Number of Students
X E1	Media Wordwall	30
X E2	Conventional Media	30
Total		60

Using a purposive sampling technique, class X E1 was designated as the experimental group using Wordwall-based interactive learning media. In contrast, class X E2 served as the control group using traditional instructional methods. The selection of these two classes was carried out with careful consideration of students' characteristics and initial competencies, thereby facilitating an objective comparison of the treatments provided. Data analysis was carried out using normality and homogeneity tests, as well as hypothesis-testing procedures. The normality test was used to determine whether the research data conformed to a normal distribution. In contrast, the homogeneity test assesses whether variances are equal across groups. After fulfilling the prerequisite tests, a two-way analysis of variance (Two-Way ANOVA) was conducted in excel to assess the effects of Wordwall-based interactive learning media, learning motivation, and their interaction on students' informatics learning outcomes.

The two-way analysis of variance model used is as follows:

$$\boldsymbol{Y_{ijk} = \mu + A_i + B_j + (AB)_{ij} + \varepsilon_{ijk}}$$

Explanation:

Y_{ijk} = student learning outcomes
μ = general average
A_i = the influence of learning media
B_j = the influence of learning motivation
$(AB)_{ij}$ = interaction of learning media and learning motivation
ε_{ijk} = research error

This investigation employed a quantitative methodology utilizing quasi-experimental techniques (quasi-experiments) alongside a 2x2 factorial design, as articulated by(Landsheer & Van Den Wittenboer, 2015). The choice of a quasi-experimental framework was necessitated by the need to achieve full randomization of participants within a Classroom setting, thereby maintaining its applicability in educational research (Hastjarjo, 2019). Simultaneously, a factorial design was implemented to examine the effects of two independent variables and their potential interactions with the dependent variable. Adopting a 2x2 factorial design in educational research facilitates the analysis of main effects and interactions; however, it is crucial to maintain sample balance to avoid compromising the interpretation of findings. Furthermore, this design is considered relevant for empirical educational research because it allows the simultaneous examination of multiple factors (White et al., 2024).

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This investigation examines the impact of Wordwall-based interactive educational media and motivational factors on students' academic performance in Computer Systems. The independent variables include educational media and learning motivation, while the dependent variable is students' academic performance (Fraenkel et al., 2012). The study was conducted at SMAN 1 North Siberut, involving a sample of 60 students selected through purposive sampling: class X E1 served as the experimental group, and class X E2 as the control group (Fraenkel et al., 2012). The purposive sampling technique was selected because the participants possessed specific characteristics relevant to the research objectives, namely students who had previously studied computer system materials and had access to digital learning media. Although this approach enabled focused investigation of the intervention, the relatively small sample size (n = 60) and single-school context may limit the generalizability of the findings to broader educational settings. Therefore, results should be interpreted within similar contextual conditions.

RESULT AND DISCUSSION

Result

This section describes the findings from the investigation into the impact of interactive learning media based on Wordwall and the role of learning motivation on the academic performance of grade-ten informatics students at SMAN 1 Siberut Utara, with a particular focus on the Computer Systems curriculum. The analytical approach used includes descriptive and inferential statistical methodologies, with a two-way ANOVA to assess the effects of the applied learning media, the level of learning motivation, and their interaction on students' educational outcomes. The purpose of this study was to examine the effect of combining interactive learning media, specifically Wordwall, with learning motivation on the academic achievement of students enrolled in the Informatics curriculum for grade X at SMAN 1 North Siberut. This study was structured using a 2x2 factorial design, combining two independent variables: learning delivery mode (Wordwall versus conventional) and learning motivation (high or low). In contrast, student learning outcomes were classified as the dependent variable. The sample for this study consisted of 60 students, divided into two groups: an experimental group (using Wordwall) of 30 students and a control group (using conventional media) of 30 students. Prior to treatment, students underwent a pre-test to assess their initial competency level, followed by the prescribed instructional method, and concluded with a post-test to evaluate the resulting learning outcomes.

Learning Outcomes Based on Treatment and Motivation

The average student learning outcomes improved significantly after treatment with Wordwall media. Details of the descriptive analysis results are presented as follows:

Table 4. Mean Pretest and Posttest Scores of Students Based on Treatment and Learning Motivation

Group	N	Average Pretest Score	Posttest Mean Score
A_1B_1– Wordwall, high motivation	22	62.26	91.42
A_1B_2 – Wordwall, low motivation	8	39.24	72.88
A_2B_1 – Conventional, High motivation	19	46.48	83.16
A_2B_2 – Conventional, low motivation	11	33.96	50.81

Empirical data showed that the most favorable learning outcomes were observed among the highly motivated cohort of learners engaged with the Wordwall medium (mean score of 91.42). In contrast, the lowest scores were recorded in the low-motivated cohort of learners who

received conventional teaching methods (mean score of 50.81). These findings imply that implementing the Wordwall medium significantly improved student learning outcomes in both high- and low-motivation groups.

Statistical Assumption Test

Before implementing a two-way ANOVA, the dataset was assessed for normality and homogeneity. The outcomes of the Liliefors test indicated that all data groups followed a normal distribution, as the computed L value was less than the tabulated L value at the 5% significance level. Additionally, the Bartlett homogeneity test confirmed that the data were homogeneous (calculated $\chi^2 = 3.847 < \chi^2$ table = 7.815).

Hypothesis Testing

Two-way ANOVA analysis was used to determine the influence and interactions between variables. The test results are presented in the following table:

Table 5. Results of the Two-Way ANOVA Test on Learning Media and Motivation toward Learning Outcomes

Source of Variance	df	JK	RJK	F count	F table (5%)	Information
Inter-media (A)	1	3454,21	3454,21	38,32	4,013	Significant
Inter-Motivation (B)	1	9811,54	9811,54	108,84	4,013	Significant
Interaction (A×B)	1	503,04	503,04	5,58	4,013	Significant
In	56	5048,20	90,15			

The results of the data analysis indicate that the use of Wordwall learning media has a significant effect on students' learning outcomes, as shown by the F-count value, which is higher than the F-table value (38.32 > 4.013). In addition, students' learning motivation also has a significant effect on learning outcomes, with an F-count value exceeding the F-table value (108.84 > 4.013). Furthermore, the analysis reveals a significant interaction between learning media and learning motivation in influencing students' learning outcomes, as indicated by the F-count value of 5.58, which is greater than the F-table value of 4.013. These findings demonstrate that both the instructional media used and students' motivational levels contribute meaningfully to learning achievement, and that their combined effect further strengthens students' learning outcomes. Therefore, all alternative hypotheses (H_1) proposed in this study are accepted.

Discussion

The findings indicate that implementing Wordwall-based interactive learning media significantly improved student performance in informatics education. The variance in mean post-test scores between the experimental and control cohorts supports this conclusion. The group of students who received Wordwall instruction achieved superior academic results compared to their peers who used the traditional pedagogical approach. The group with the highest academic performance was identified as A_1B_1 (Wordwall high motivation), with a mean score of 91.42, compared with the A2B2 cohort (conventional low motivation), which recorded a mean of only 50.81. This disparity implies that the use of interactive digital learning media can substantially improve the effectiveness of the educational process (Ramadhani et al., 2025).

These empirical findings are consistent with recent Scopus research indicating that integrating gamification into educational contexts significantly improves student learning outcomes, with moderate to high effects (M. Li et al., 2023). Furthermore, a recent meta-analysis also demonstrated that learning modalities based on gamification and digital interactive media can significantly improve students' academic performance compared to traditional pedagogical approaches (Darina Dicheva et al., 2015). The improvement in learning outcomes can be attributed to Wordwall's distinctive features, which facilitate gamification-based education through interactive elements such as quizzes, educational games, challenges, and immediate feedback. The interactive educational environment fosters high levels of active student participation during the learning process. Furthermore, captivating visual presentations and

dynamic learning activities increase student attention, concentration, and engagement in understanding concepts related to Computer Systems (Mahamad et al., 2024; Marquardt et al., 2025).

Improved academic performance is intrinsically linked to Wordwall's attributes, which facilitate gamified education through quizzes, games, challenges, and immediate feedback. The participatory learning environment encourages increased student engagement throughout the educational process. Furthermore, engaging visual representations and interactive learning tasks contribute to increased student concentration, focus, and understanding of Computer Systems content. This aligns with contemporary research showing that gamification-based platforms such as Wordwall can enhance student engagement, motivation, and academic outcomes through an interactive, activity-centered pedagogical approach (Widhiatama & Brameswari, 2024; Mubarrat et al., 2026). These findings suggest that Wordwall implementation is significantly more effective than traditional instructional methods.

This phenomenon can be explained by the capacity of gamification-oriented media to significantly increase student engagement through the implementation of challenge mechanisms, immediate feedback, and experiential learning activities. Empirical research shows that integrating gamification into educational contexts consistently improves student engagement and academic performance relative to traditional pedagogical approaches, as it encourages active participation and fosters intrinsic motivation (Baptista & Oliveira, 2019; Sailer & Homner, 2020). Furthermore, a recent comprehensive meta-analysis demonstrated that incorporating gamification elements into educational frameworks produces a markedly positive effect on learning outcomes when paired with conventional teaching methods (Xu et al., 2025).

Further findings indicate that the construct of learning motivation significantly influences academic performance among students. Learners with high motivation consistently achieved superior academic outcomes compared to peers with lower motivation, regardless of the learning modality (Wordwall or traditional). This observation aligns with the conclusions of recent meta-analyses that describe the beneficial impact of gamification on motivation and educational outcomes, where motivation serves as a crucial element that enhances the efficacy of digital learning environments (Furkan Kurnaz & Koçtürk, 2025; Ratinho et al., 2026). Additional research has corroborated that learning experiences based on gamification substantially increase students' intrinsic motivation and engagement, thereby improving learning outcomes (L. Li et al., 2024; Qudsi, 2024).

Furthermore, contemporary systematic research indicates that gamification components, including challenges, rapid feedback, and incentive mechanisms, significantly contribute to maintaining increased levels of student learning motivation throughout the educational experience (Tomaylla-Quispe et al., 2026). Consequently, the differences in average learning outcomes between highly motivated and low-motivated students in this study reinforce the premise that learning motivation is a crucial determinant of success in digitally facilitated learning.

Empirical evidence suggests that intrinsic motivation is a crucial determinant of students' success in understanding educational content. Learners who exhibit high levels of motivation tend to be more actively engaged, exhibit increased curiosity, and demonstrate resilience in overcoming academic tasks and challenges. Conversely, individuals with reduced motivation tend to exhibit lower engagement, which, in turn, negatively affects their academic performance. This observation is corroborated by a recent meta-analysis, which found that learning motivation significantly influences educational outcomes across diverse digital learning environments and gamification frameworks (Zhang & Yu, 2020; Gyedu et al., 2026).

Statistically, the impact of learning motivation on academic outcomes was highly significant, as evidenced by an F-value of 108.84, which substantially exceeds the F-table threshold of 4.013. These results support the assertion that learning motivation serves as a crucial determinant of educational success, particularly in interactive learning contexts. Contemporary research further corroborates that intrinsic motivation consistently enhances

student engagement and academic achievement in technology-mediated learning environments (N. Nikolov, 2023; Dai et al., 2025). Within the framework of 21st-century education, learning motivation has emerged as a crucial component, as learners are increasingly required to demonstrate greater levels of activity, autonomy, and adaptability in utilizing digital technologies for educational purposes. Consequently, the role of educators goes beyond mere content dissemination; instead, it encompasses the responsibilities of facilitators who foster motivation and create a learning environment that effectively promotes student engagement.

The findings from the two-way ANOVA analysis revealed a statistically significant interaction between the implementation of the Wordwall learning media and the construct of learning motivation in relation to students' academic performance, evidenced by an F score of 5.58, which exceeds the critical value of Ftable (4.013). This observation implies that the efficacy of gamification-based educational media depends on intrinsic factors related to students, especially their learning motivation. This statement is corroborated by contemporary research showing that the impact of gamification on educational outcomes is moderated, with motivation serving as an important catalyst in the relationship between digital learning media and students' academic success (Jaramillo-Mediavilla et al., 2024; Dai et al., 2025).

Students who exhibit high levels of motivation show greater improvement in educational outcomes when using Wordwall than their low-motivation peers. This phenomenon can be attributed to the fact that gamification encourages increased active engagement, instills a sense of competition, and fosters a challenge-oriented learning environment that strengthens students' cognitive engagement. Recent empirical investigations have confirmed that gamification significantly increases intrinsic motivation and learning engagement, which are directly correlated with improved educational outcomes, especially among students with high levels of motivation (Berei & Kovács, 2025).

Nevertheless, research indicates that Wordwalls have a positive effect on students with low learning motivation. Engaging components such as games, competitions, rewards, and visual representations can serve as external stimuli that increase student attention and participation during the educational process. Consequently, the implementation of Wordwalls serves not only as an instructional medium but also as a pedagogical approach to increase student motivation and enrich the learning experience in a fun and meaningful way. The results of this investigation imply that the efficacy of informatics education does not depend solely on the application of educational technology but is also shaped by learners' psychological dimensions, particularly learning motivation. Thus, combining interactive digital learning resources with strategies designed to enhance learning motivation is an important framework for building effective, adaptive, and relevant educational practices that meet the demands of 21st-century education.

CONCLUSION

Research findings indicate that implementing interactive educational media based on Wordwall has a substantial impact on the informatics learning outcomes of secondary school students. Learners who engage in educational activities using Wordwall achieve superior academic outcomes compared to peers who use traditional teaching methods. Furthermore, learning motivation has been identified as an important determinant influencing students' academic success. Individuals who exhibit high levels of learning motivation consistently achieve higher academic performance than those who exhibit lower levels of motivation. This study also revealed a noteworthy interaction between the utilization of Wordwall media and learning motivation in relation to student learning outcomes. These results imply that the efficacy of gamification-oriented educational media is influenced not only by the quality of the media used but also by students' psychological states, particularly their learning motivation.

In this context, Wordwall facilitates the creation of a more interactive, adaptive, and learner-centered educational environment through game-based activities, challenges, and immediate feedback mechanisms that enhance students' cognitive and emotional engagement

throughout the educational process. Theoretically, this investigation reinforces the view that integrating digital technology and gamification methodologies in education can enhance the quality of students' learning experiences. In practice, the research findings suggest that educators should design pedagogical strategies that not only incorporate interactive digital media but also continuously cultivate students' intrinsic learning motivation. Consequently, the implementation of Wordwall can serve as a viable alternative to innovative pedagogical strategies that support more effective, meaningful, and relevant informatics education to meet the demands of 21st-century education.

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