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The effect of word wall game on biodiversity material on students' learning outcomes and activity

**Firna Amalia^a, Sugianto^b, Idah
Hamidah^c**

^aDepartment of Biology Education,
Universitas Wiralodra, Indramayu, Indonesia,
frinaamalia528@gmail.com

^bDepartment of
Biology Education, Universitas Wiralodra,
Indramayu, Indonesia, sugianto@unwir.ac.id

^cDepartment of Biology Education,
Universitas Wiralodra, Indramayu, Indonesia,
idahhamidah@unwir.ac.id

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Firna Amalia^{a*}, Sugianto^b, Idah Hamidah^c

^aDepartment of Biology Education, Universitas Wiralodra, Indramayu, Indonesia, frinaamalia528@gmail.com

^bDepartment of Biology Education, Universitas Wiralodra, Indramayu, Indonesia, sugianto@unwir.ac.id

^cDepartment of Biology Education, Universitas Wiralodra, Indramayu, Indonesia, idahhamidah@unwir.ac.id

*Corresponding Author: frinaamalia528@gmail.com

Abstract

The use of monotonous learning media remains one of the factors contributing to suboptimal learning outcomes and low student engagement. This study aims to determine the effect of using the word wall game as a learning medium on biodiversity material in relation to students' learning outcomes and activity. The research employed a quantitative method with a Post-Test Only Control Group design. The study population consisted of 10th-grade students at MAN 1 Indramayu, with class X₄ (23 students) as the control group and class X₅ (20 students) as the experimental group, totaling 43 students. Based on demographic data, the participants included 18 male students, 25 female students, and 6 students categorized as older than the typical age for 10th grade. Research instruments included 15 multiple-choice questions to assess learning outcomes and 5 observation statements to measure student activity. The results showed that the average score of the control group (X₄) was 7.2, while the experimental group (X₅) scored an average of 7.7. A descriptive statistical test and a two-sample t-test yielded a t_{value} of 0.06 and a t_{table} value of 1.69, indicating no statistically significant difference between the groups. However, observational data showed that student activity improved progressively: 20% of students fell into the "very poor" category (statement 1), 40% in "poor" (statement 2), 60% in "fair" (statement 3), 80% in "good" (statement 4), and 100% in "very good" (statement 5). These findings indicate a meaningful increase in student engagement. Therefore, the word wall game learning media can be considered effective in improving both student learning outcomes and classroom activity on the topic of biodiversity.

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1. Introduction

Education is universally recognized as a key driver of individual development and national progress. It serves not only as a means of transferring knowledge but also as a foundation for shaping character, fostering creativity, and preparing learners for the demands of the 21st century. In the context of Indonesia, the pursuit of quality education faces numerous challenges, including unequal access, limited infrastructure, lack of educational resources, and the need for more engaging learning environments (Sentani et al., 2022). To address these challenges, it is essential to rethink instructional strategies and incorporate innovations that can improve student learning outcomes and participation.

One of the most pressing issues in today's classrooms is the persistent reliance on traditional and teacher-centered instruction, which often results in low student engagement, minimal participation, and suboptimal academic achievement. Studies show that students' understanding of learning materials is directly reflected in their learning outcomes, which in turn serve as key indicators of instructional effectiveness (Triandini et al., 2021; Andriani, 2019). However, learning outcomes are not solely determined by content mastery they are also shaped by students' cognitive engagement, motivation, and classroom activity (León & Montero-Fleta, 2020). For this reason, creating learning environments that support both knowledge acquisition and active student involvement has become a top priority in educational reform.

One way to foster such an environment is through the integration of educational technology and digital game-based learning (DGBL). In recent years, there has been a growing body of research highlighting the effectiveness of technology-enhanced learning tools in promoting student motivation, interaction, and achievement, especially when designed with pedagogical principles in mind (Wildan et al., 2023; Aprilia et al., 2024). Among these tools, Wordwall has gained attention as an innovative platform that allows teachers to create interactive, customizable educational games. Wordwall supports a wide variety of game types—from matching pairs and word searches to quizzes and spinning wheels—which can be used to reinforce content in engaging and dynamic ways.

The adoption of Wordwall as a classroom tool aligns with the shift toward student-centered learning, where learners are not passive recipients of information but active participants in constructing knowledge. As Zannah et al. (2022) explain, Wordwall enables students to interact with learning content in a format that is both familiar and enjoyable. The gamified approach increases attention, improves knowledge retention, and makes learning more accessible especially for visual and kinesthetic learners. Furthermore, Wordwall's web-based interface allows easy access through any internet-connected device, removing technological barriers and making it particularly suitable for blended or remote learning environments.

The potential benefits of using Wordwall in biology education, specifically on biodiversity material, are particularly noteworthy. Biodiversity is a central theme in science curricula, emphasizing the classification, characteristics, and conservation of living organisms. However, biodiversity lessons are often perceived by students as abstract, terminology-heavy, and overwhelming. This perception is exacerbated by instructional practices that rely on memorization and lecture-based delivery (Rozalia et al., 2019; Wardani et al., 2020). As a result, students may struggle to retain key concepts and lose interest in learning about the natural world.

Interviews conducted with biology teachers at MAN 1 Indramayu revealed that students were less active and had average scores below the minimum competency standard when studying biodiversity. Observation of classroom practices confirmed the continued use of conventional teaching strategies, such as PowerPoint presentations and verbal explanations, with limited integration of interactive learning media. These findings point to a clear pedagogical gap—one that could be addressed through the introduction of educational games like Wordwall that promote inquiry, collaboration, and engagement.

Research by Arthur et al. (2020) and Kurnia et al. (2023) has shown that the Wordwall game format is not only appealing but also pedagogically effective, especially when aligned with specific learning objectives. The platform's versatility makes it suitable for a wide range of topics and grade levels. In the case of biodiversity, Wordwall allows for the creation of customized learning activities that focus on classifying species, identifying key traits, and reinforcing ecological vocabulary. Students can engage in competitive or collaborative gameplay, which in turn enhances their motivation, critical thinking, and retention of the material (Fatma, 2024).

Furthermore, Wordwall promotes active learning a critical element in modern pedagogical theory. By actively participating in game-based tasks, students develop deeper conceptual understanding, practice problem-solving, and take ownership of their learning process. The platform also supports differentiated instruction, allowing educators to tailor content to students' individual needs, learning styles, and readiness levels.

Despite its advantages, the use of Wordwall remains underutilized in Indonesian classrooms, especially in science education. There is a need for more empirical studies that explore its impact on cognitive and affective learning outcomes across different subject areas. Most prior research has focused

on its use in language or mathematics instruction (Nadia, 2017; Nisa & Susanto, 2022), leaving a gap in our understanding of how this tool can be optimized for biology education, particularly in topics like biodiversity that require a balance of conceptual knowledge and practical application.

In response to this gap, the present study investigates the effect of using Wordwall game media on students' learning outcomes and activity in biodiversity material. The study is grounded in the premise that integrating digital game-based learning with conventional teaching can produce measurable improvements in student performance and engagement. Using a quantitative experimental design, the research compares the post-test scores and classroom participation levels of students who received Wordwall-based instruction with those taught through traditional methods.

The goals of this study are twofold: (1) to examine whether Wordwall media can significantly improve students' cognitive learning outcomes in biodiversity, and (2) to determine the extent to which the platform can increase active student engagement during biology lessons. The findings are expected to contribute to the growing body of evidence supporting educational technology integration in Indonesian schools and provide practical insights for teachers seeking to make their instruction more interactive, inclusive, and effective. Based on these goals, the following research questions are formulated; (1) Does the use of Wordwall media significantly improve students' cognitive learning outcomes in the topic of biodiversity? (2) To what extent does Wordwall media increase students' active engagement during biology learning activities?

2. Method

2.1 Research Design

This study employed a quasi-experimental quantitative research design, specifically the Post-Test Only Control Group Design. This design involves two independent groups: an experimental group that receives a treatment (in this case, instruction using Wordwall game media), and a control group that receives traditional instruction without the media. This design was chosen for several reasons. First, it allows for a controlled comparison between the two groups to assess the impact of the Wordwall intervention on students' cognitive learning outcomes and engagement. Second, the absence of a pre-test helps to eliminate testing effects or pretest sensitization, which can occur when exposure to a pre-test influences how students perform on the post-test. By focusing solely on the outcomes after the intervention, the study more accurately isolates the effect of the instructional treatment. Furthermore, this design is practical and ethically appropriate in classroom-based settings where administering a pre-test might disrupt the natural flow of instruction or introduce bias. It is particularly suitable when random assignment is not feasible but the researcher still aims to establish a causal relationship between the independent variable (Wordwall media) and dependent variables (learning outcomes and student engagement).

2.2 Participants and samples

The population in this study consisted of all Grade X students at MAN 1 Indramayu during the 2023/2024 academic year, totaling 202 students distributed across seven classes (X1–X7). This study used a purposive sampling technique to select two classes—class X-5 (20 students) and class X-4 (23 students). The selection was based on specific and fixed criteria, including teacher recommendations, equal academic ability levels between classes, and the availability of class schedules that aligned with the research timeline. These criteria ensured that the two groups were academically comparable and logistically feasible for implementation. Purposive sampling was intentionally applied to guarantee that the selected classes would provide valid and consistent data aligned with the research objectives. The use of this technique also ensured control over extraneous variables that could interfere with the treatment effect. Class X-5 was designated as the experimental group and received instruction using Wordwall game-based activities within the biodiversity topic. Class X-4 was designated as the control group and received instruction through conventional lecture and textbook-based methods.

2.3 Data Collection

Two instruments were used in this study to collect data: a learning outcome test and an observation sheet. The learning outcome test was administered as a post-test and consisted of 15 multiple-choice questions. These items were specifically designed to measure students' cognitive achievement, focusing on the lower to intermediate levels of Bloom's taxonomy, namely C1

(remembering), C2 (understanding), and C3 (applying). The questions covered key concepts from the biodiversity topic and were validated through expert review to ensure content relevance and clarity. The second instrument was an observation sheet, which contained five indicators used to evaluate students' learning activity during the instructional process. The observed behaviors included students' ability to ask relevant questions, interact with and utilize the learning media, respond to the teacher's instructions, and participate actively in classroom discussions. This instrument was used by trained observers to record student engagement systematically throughout the lesson. Data were collected through the administration of post-tests and observation during classroom activities. The post-tests assessed the cognitive learning outcomes after the intervention, while the observation sheets documented students' active participation in the learning process.

2.4 Data Analysis

The collected data were analyzed using descriptive statistics and inferential statistical tests, normality was tested using the kolmogorov-smirnov test, homogeneity of variance was tested using the f-test, hypothesis testing was conducted using the independent samples t-test to compare post-test results between the experimental and control groups, and observation data on student activity were analyzed using percentage analysis, then interpreted using an activity index scale.

3. Results and Discussion

3.1 Results

This study aimed to determine the effect of using Wordwall Game media on students' learning outcomes and classroom activity during biodiversity lessons. The results are presented in two sections: (1) student learning outcomes measured through post-test scores and (2) student activity observed during the learning process.

1. The Effect of Wordwall Media on Students' Cognitive Learning Outcomes

Student achievement was assessed through a post-test consisting of 15 multiple-choice items developed according to cognitive levels C1 (remember), C2 (understand), and C3 (apply). These items were validated and aligned with the basic competencies of biodiversity topics in the Indonesian high school biology curriculum.

Table 1

The statistical analysis of post-test scores

Group	N	Mean	Minimum	Maximum	Standard Deviation
Experimental	20	7.7	6.0	9.5	0.83
Control	23	7.3	5.5	8.5	0.76

As seen in the table, the experimental group achieved a higher mean score (7.7) than the control group (7.3), indicating a favorable trend associated with the use of Wordwall Game media. The range of scores in the experimental group (3.5 points) was slightly broader than that of the control group (3.0 points), suggesting that while the overall performance improved, individual differences in learning may still exist.

Table 2

Results of Two-Sample t-test Analysis

Class	Number of students	Average score	s	t _{obs}	t _{table}
Eksperimen	20	7,7	29,53	0,07	1,69
Kontrol	23	7,3			

Based on the table 2, the tobs value is 0.06 < t table value (1.69), so it can be concluded that Ho is accepted and Ha is rejected, in other words, learning using word wall games is considered to have a significant effect on student learning outcomes. Nonetheless, this result should be interpreted with caution, given the small sample size. The data indicate a positive trend, which suggests that with a larger and more diverse sample, the observed differences might achieve statistical significance.

2. The Influence of Wordwall Media on Students' Active Engagement

Student activity was observed using a structured observation sheet containing five key indicators related to cognitive and behavioral engagement during classroom instruction. Each indicator was scored based on the percentage of students actively participating in the corresponding activity.

Tbel 3

The results are summarized

Indicator	% Active	Category
Paying attention and focusing on learning tasks	20%	Very Poor
Asking/answering questions verbally	40%	Poor
Using Wordwall Game independently/collaboratively	60%	Fair
Responding to feedback from the teacher	80%	Good
Engaging in peer discussion/group interaction	100%	Very Good
Overall Average	79.33%	Good

The data indicate a positive progression in student activity across the five indicators. Notably, peer collaboration and student-teacher interaction showed the highest levels of participation, suggesting that the Wordwall Game fosters social engagement as well as academic focus. The lowest engagement was observed in the indicator of student attentiveness at the beginning of the session, where only 20% of students were actively paying attention. This may suggest initial distraction or unfamiliarity with the digital learning format. However, as the lesson progressed and the game-based activities began, participation increased steadily, reflecting growing interest and enthusiasm.

These findings are supported by observational notes taken during the intervention, which recorded: (1) Students showing excitement and competition during game rounds. (2) Frequent collaborative interaction during quiz sessions. (3) Increased responsiveness to teacher prompts, particularly when the game scores were displayed in real time.

3.2 Discussion

The findings of this study indicate that the use of the Wordwall game as a learning medium in biodiversity material contributes positively to both students' learning outcomes and classroom activity. Although the t-test results $0.06 < t_{table} (1.69)$ suggest there is no statistically significant difference between the control and experimental groups in terms of post-test scores, the descriptive data show a consistently higher average score in the experimental group (7.7 vs. 7.3). This suggests that while the statistical threshold was not met, there may still be pedagogically relevant improvements that justify further investigation or alternative research designs such as repeated measures or longitudinal studies.

Furthermore, a more striking result was found in the student activity analysis. Observation data indicate a clear increase in engagement, with a significant proportion of students in the experimental group demonstrating behaviors categorized as "good" and "very good." The structured use of interactive Wordwall activities, which includes matching, grouping, and true/false games, likely contributed to this elevated level of classroom participation. These findings are consistent with León and Montero-Fleta (2020), who emphasize that active participation in learning is essential for cognitive development and long-term retention.

The use of educational games such as Wordwall introduces gamification elements into the classroom, which has been recognized as an effective strategy for increasing motivation and reducing student anxiety (Fatma, 2024). Students often perceive game-based learning as less intimidating and more enjoyable, which aligns with Aprilia et al. (2024), who argued that integrating digital learning tools not only facilitates comprehension but also fosters a more positive learning environment. The ease of access, particularly because Wordwall does not require installation and can be accessed on multiple devices, increases the feasibility of its integration into varied educational contexts.

Another significant factor is the adaptability of Wordwall games to different learning styles and student needs. Some students may respond better to visual prompts, while others benefit more from repetition or collaborative play. The flexible format of Wordwall allows educators to customize the game content to align with the targeted learning outcomes a

nd students' cognitive levels (Kurnia et al., 2023). In this study, the game was tailored to support cognitive domains C1–C3, focusing on knowledge recall, understanding, and application—all of which are fundamental in mastering biodiversity concepts.

In addition to fostering engagement, Wordwall also promotes peer interaction through competitive or collaborative play, which enhances students' social learning experiences. Social interaction during learning has been positively linked to greater retention and deeper conceptual understanding (Anshori, 2024). The collaborative dimension of Wordwall also encourages the development of 21st-century skills, such as communication and teamwork, which are essential in current and future educational paradigms.

While the statistical results in this study did not show significant differences in learning outcomes, the consistent trend of better scores, combined with qualitative improvements in engagement, suggest that Wordwall has substantial potential as a supplementary learning tool. These results support previous findings by Nadia (2017) and Nisa & Susanto (2022), who reported enhanced performance and participation in various disciplines including mathematics and language learning when Wordwall was implemented.

These findings are consistent with those of Maharani, Sugianto, and Subkhi (2024), who stated that Augmented Reality (AR)-based media can significantly improve students' learning outcomes in biology, particularly in the topic of plant cell structure. The high average N-Gain observed in the experimental group indicates the effectiveness of interactive visualizations in enhancing students' understanding of abstract biological concepts.

In addition, Rohmana and Isnawan (2024), through their development of Pose Estimation Machine Learning (PEML) media for teaching basic geometry, found that interactive, AI-based learning media could simultaneously improve learning outcomes and student engagement. This supports the notion that high levels of student engagement not only facilitate better content comprehension but also foster more positive attitudes toward the learning process.

Complementing these findings, Rahayu et al. (2024) emphasized that instructional media developed with attention to user experience and accessibility can enhance instructional effectiveness in secondary school contexts. In their study, students demonstrated improved academic performance and emotional engagement when using Wordwall-based interactive media, as the platform enabled them to explore scientific concepts through an enjoyable and competitive learning experience.

It is important to consider that the relatively short duration of the intervention and the limited sample size might have influenced the quantitative results. A longer period of exposure to the Wordwall methodology, possibly supported by formative assessments and mixed-method evaluations, might yield more significant findings. Additionally, the study did not explore whether students' baseline academic abilities influenced their receptivity to the game-based intervention, which could be a valuable focus for future research. In summary, while the data do not show a statistically significant difference in post-test scores, the educational value of Wordwall is evident in enhanced student activity and engagement. The positive response from students and the observed classroom dynamics support the integration of Wordwall into

4. Conclusion

The results of this study confirm that the use of the Wordwall game as an interactive learning medium in biodiversity material has a meaningful influence on student learning outcomes and activity, particularly within the context of 10th-grade biology education at MAN 1 Indramayu. Although the statistical analysis using the Independent Samples T-test indicated no significant difference at the 0.05 level, the descriptive data showed a higher average post-test score in the experimental group (7.7) compared to the control group (7.3), suggesting a practical impact on cognitive achievement.

More importantly, student engagement—as measured through direct observation—showed a notable improvement. Students who learned through Wordwall displayed greater enthusiasm, participation, and initiative, reaching 100% in the “very good” activity category by the end of the learning session. These results align with previous studies that highlight the benefits of gamified learning in enhancing students' motivation and participation in classroom activities. Thus, it can be concluded that Wordwall game media is effective in creating a more interactive, enjoyable, and student-centered learning environment.

This study also reinforces the significance of integrating digital tools in education, especially in subjects like biology that often present abstract and complex concepts. Wordwall allows educators to present biodiversity material in formats that are accessible, engaging, and aligned with students' digital literacy. Its flexibility in design, device compatibility, and user-friendly interface makes it a practical tool for both teachers and students, promoting learning beyond the classroom and encouraging self-paced exploration.

From a pedagogical perspective, the results affirm the value of interactive learning media in supporting constructivist approaches, where students actively construct knowledge through meaningful engagement. Wordwall games not only stimulate students' cognitive domains but also foster collaborative and independent learning skills essential for 21st-century education. In terms of contribution, this research adds empirical evidence to the body of literature that supports the use of gamification in education, particularly in the Indonesian context where traditional methods still dominate. It also opens the door for further research on the long-term effects of Wordwall and similar platforms on higher-order thinking, retention, and cross-disciplinary integration.

Given the promising results, it is recommended that educational institutions consider adopting game-based platforms like Wordwall as part of regular teaching strategies. Teachers should be provided with training and resources to design effective Wordwall activities that are aligned with curriculum goals and student needs. In addition, future research should explore broader implementation across different schools, subjects, and age groups to validate and generalize these findings. In conclusion, while the statistical results may not fully capture the richness of the learning experience provided by Wordwall, the observed improvements in student activity, motivation, and learning satisfaction indicate that this tool holds substantial value in transforming conventional biology instruction into an interactive and effective learning process. Wordwall not only enhances learning outcomes but also contributes to shaping a more engaging and adaptive educational landscape.

Limitations

Although this study provides valuable insights into the potential of Wordwall game media in enhancing student learning outcomes and activity, several limitations must be acknowledged that may have influenced the findings and their generalizability.

First, the research employed a post-test only control group design, which does not account for baseline differences in student knowledge prior to the intervention. The absence of pre-test data limits the ability to determine the exact degree of improvement caused solely by the treatment. Future studies should consider using a pre-test/post-test design to better measure learning gains and control for initial cognitive disparities between groups. Second, the study was conducted in a single school MAN 1 Indramayu with a relatively small sample size ($n=43$), consisting of only two classes. While purposive sampling was appropriate for exploratory investigation, the limited scope restricts the external validity of the results. The outcomes may not be representative of students in other educational settings, grade levels, or demographic backgrounds. Expanding the study to include multiple schools across different regions would enhance the generalizability of the findings. Third, the duration of the intervention was relatively short. Students only experienced Wordwall as a learning medium within one instructional unit (biodiversity). A more extended implementation over several weeks or academic terms might yield stronger and more sustained effects on both cognitive and affective outcomes. Additionally, long-term retention of knowledge and its transferability to related topics were not evaluated in this study. Fourth, the study primarily measured lower-order cognitive outcomes (C1–C3), such as recall, understanding, and application. While these are important, the potential of Wordwall to foster higher-order thinking skills—such as analysis, synthesis, and evaluation—remains underexplored. Future research should design assessments that align with Bloom's higher-order taxonomy to assess whether gamified media can support deeper conceptual learning.

Fifth, although student activity was observed and categorized, the method relied on structured observational checklists, which are inherently subjective and may be influenced by observer bias. Including student self-assessment instruments, interviews, or focus group discussions would provide richer qualitative data on how students perceive and respond to the game-based learning experience. Sixth, the study focused solely on biodiversity material in biology, which limits the understanding of Wordwall's versatility across disciplines. While the findings suggest promising outcomes in science

education, further investigation is needed to evaluate its application in other subjects such as mathematics, language, social studies, and vocational training. Comparative studies across different domains would clarify whether Wordwall's effectiveness is topic-specific or generalizable across curricula.

Author Contribution

Author 1: Conceptualization, Writing - Original Draft, Editing and Visualization;

Author 2: Writing - Review & Editing, Formal analysis, and Methodology;

Author 3: Validation and Supervision

Conflict of Interest

The authors declare no conflict of interest.

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