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The Effectiveness of Discussion Methods Assisted with *Wordwall* Media to Improve High School Student Learning Outcomes Human Movement System Material

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Abstract

This study aims to analyze the effectiveness of the wordwall-assisted discussion method in improving high school students' learning outcomes in the Human Movement System material. This study used a quasi-experimental study with a pretest-postest model. The subjects were grade XI students of SMA NU Lemahabang, divided into two groups: the experimental class using the wordwall- assisted discussion method and the control class using the lecture method. Data collection was carried out through pretests, postests, and student response questionnaires. The results showed that in the N-gain value in the experimental class, 82.5% of students experienced an increase in learning outcomes in the moderate to high category. In contrast, in the control class, only 31.25% of students reached that category. Based on these results, 75% of students in the experimental class were declared to have completed the material, while in the control class only 43.75% completed the material. In addition, student responses to the wordwall- assisted discussion method were in the very good category. These findings prove that the wordwall-assisted discussion method is effective in improving students' cognitive learning outcomes. The implications of this research show that combining discussion methods with interactive digital media can significantly improve the quality of Biology learning.

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INTRODUCTION

Education serves as the fundamental foundation for shaping high-quality human resources who are competitive in the global era. Therefore, a nation's success in facing contemporary challenges largely depends on the quality of education provided to its younger generations (Rizal, 2023). Consequently, Indonesia's education system must continuously adapt to advances in science and technology to avoid being left behind by other countries. In today's digital era, technological transformation has significantly reshaped various aspects of life, including education. Teaching and learning methods are no longer confined to conventional classrooms but have expanded into more interactive and flexible digital environments (Aeni & Hidayat, 2022).

Biology is one of the core subjects in senior high school that explores essential concepts of life. For instance, the topic of the Human Movement System aims to help students understand the structure of bones, muscles, joints, and the mechanisms of body movement (Novitasari & Susantini, 2021). However, in practice, many students struggle to grasp this material due to its abstract nature and the analytical skills it requires. This often results in low student achievement and less optimal learning outcomes.

The rapid development of information technology has had a profound impact on education. Teachers are now expected not only to master the subject matter but also to integrate digital technology into their teaching practices (Yusuf & Widyaningsih, 2021). This is particularly important because Generation Z, who currently make up the majority of students, has unique characteristics: they are generally more interested in technology-based and interactive activities. Without adaptation, student motivation and engagement may decline, ultimately affecting learning outcomes.

Digital technology has driven various innovations in education, such as interactive media, online learning applications, and web-based assessment platforms. These innovations are expected to enhance student motivation, participation, and academic achievement (Aribowo, 2021). Nevertheless, in many schools, including SMA NU Lemahabang, teaching is still dominated by traditional methods such as lectures and independent assignments. These approaches are often insufficient in meeting the needs of today's learners, who are more critical, creative, and familiar with technology (Putri & Rahayu, 2024).

One of the key indicators of educational success is student learning outcomes. Learning outcomes reflect students' ability to understand knowledge, develop skills, and demonstrate positive attitudes after the learning process. Sarwendah (2023) explains that multiple factors influence learning outcomes, including motivation, interest, instructional strategies, and the teaching media employed. Thus, selecting appropriate methods and media is crucial to significantly improving student performance.

Huda (2017) emphasizes that the discussion method is one effective alternative teaching strategy, as it encourages students to actively express opinions, exchange ideas, and analyze problems collaboratively. Similarly, Gunawan et al. (2020) highlight that this method provides greater opportunities for student participation while the teacher takes on the role of facilitator. Such interaction fosters two-way communication and helps students develop critical thinking and communication skills.

The main advantage of the discussion method lies in its ability to give students a more active role in the learning process. In practice, the teacher functions as a facilitator who guides the discussion, while students become the main subjects exploring concepts and solutions to problems. This shift allows students to dominate the learning process by up to 80–85%, aligning with the Merdeka Curriculum's emphasis on active participation and independent learning (Kurniasih & Sani, 2021).

In addition to teaching methods, the use of supporting media is essential to make the learning process more engaging and effective. One widely used digital medium is wordwall, a web-based application that provides various templates for interactive quizzes, puzzles, and educational games (Aribowo, 2021). This platform enables active student participation while also facilitating teacher-led evaluations. Research has shown that the use of wordwall enhances students' motivation, engagement, and achievement by creating a more enjoyable and interactive learning experience (Kajian & Pratiwi, 2023).

In the context of Biology, particularly the Human Movement System, wordwall can assist students in understanding abstract concepts through visualization and interactive simulations. This aligns with students' preference for technology-based learning and their need for challenging and applicable learning experiences (Rifqiawati & Tanjung, 2021). By combining the discussion method with wordwall media, learning is expected not only to improve student comprehension but also to create a more enjoyable and interactive classroom experience.

Based on observations and interviews conducted at SMA NU Lemahabang with the Biology teacher, Mr. Deden Komara, S.Pd., it was found that the teaching of Biology particularly the Human Movement System, still relies on lecture-based methods and assignments through student worksheets. This approach has led to passive learning attitudes, where students are less engaged in the process. As a result, many students simply copy answers from their peers without fully understanding the concepts being taught. Consequently, student achievement remains relatively low, as reflected in the mid-semester summative test

results, where more than half of the students in classes XI 1 through XI 4 failed to meet the school's minimum mastery criterion of 70.

In practice, students tend to rely heavily on rote memorization, which prevents them from developing a deeper conceptual understanding. As a result, the Human Movement System is perceived as a difficult topic, and students often lack confidence when solving analytical questions. Moreover, the one-directional nature of traditional teaching methods limits opportunities for students to ask questions, engage in discussions, and express their ideas. These conditions highlight the need for innovative learning strategies that can foster active student participation and improve learning outcomes. The discussion method supported with wordwall is considered a promising solution, as it combines collaborative learning with interactive media that aligns with the characteristics of 21st-century learners. Through discussions, students are directly involved in the construction of knowledge, while wordwall serves as a stimulus and supporting tool for the learning process (Yusuf & Widyaningsih, 2021).

Previous studies have demonstrated the effectiveness of wordwall in various subjects, such as economics (Minarta, 2022) and Islamic ethics (Nurhayati, 2024). However, research that integrates the discussion method with wordwall specifically in teaching Biology—particularly the Human Movement System—at the senior high school level remains limited. This gap forms both the novelty and the significance of the present study. Accordingly, this research aims to contribute to the development of technology-based learning strategies in Biology that are better suited to the characteristics of 21st-century students.

Based on this background, the researcher conducted a study entitled "The Effectiveness of the Discussion Method Assisted with Wordwall Media in Improving High School Students' Learning Outcomes on the Human Movement System." The results of this study are expected to provide practical references for Biology teachers in selecting innovative learning strategies and to contribute to the improvement of education quality in secondary schools.

RESEARCH METHOD

This study employed a quantitative approach with an experimental design. The approach was applied to measure and analyze the effectiveness of the discussion method assisted with wordwall media in improving senior high school students' learning outcomes on the Human Movement System. The type of research used was a quasi-experimental design with a pretest–posttest format. The study was conducted at SMA NU Lemahabang, located on Jalan Raya Pande, Sindanglaut, Lemahabang District, Cirebon Regency, West Java 45183, during the second semester of the 2024/2025 academic year. The population consisted of students from classes XI 1 through XI 4. Based on recommendations from the Biology teacher and field conditions, the sample was determined using the Slovin formula, involving four Biology classes with a total of 137 students. The instrument trial was conducted in class XI 4, while the research sample included class XI 1 and XI 2 as the experimental groups, which applied the discussion method

RESULTS AND DISCUSSION

This study aims to analyze the effectiveness of the discussion method assisted with wordwall media in improving senior high school students' learning outcomes on the Human Movement System. The research was conducted at SMA NU Lemahabang using a quasi-experimental design with a pretest–posttest control group. The experimental class applied the discussion method assisted with wordwall media, while the control class used the lecture method.

Effectiveness of the Discussion Method Assisted with Wordwall Media

Hasil Students' cognitive learning outcomes in this study were obtained through a pretest administered at the beginning of the lesson (first meeting) and a posttest at the end of the lesson (final meeting). The instrument trial was conducted in one class, namely class XI 4 of SMA NU Lemahabang. The effectiveness of the learning method was determined from students' posttest scores. Measurement of student learning outcomes was carried out using pretests and posttests consisting of 20 multiple-choice items, which had undergone both validity and reliability testing.

The pretest and posttest results were analyzed using the N-Gain test to measure the improvement in students' learning outcomes. The classical results of students' learning performance are presented in the following tables:

Table 1. Results of the N-Gain Test on Students' Learning Outcomes

Class	Students (n)	N- Gain Score	Category	Percentage	Total Percentage
Control	22	< 0,3	Low	69 %	
32	5	0,3 – 0,7	Medium		
	5	0,7	Hight	31,25%	
Experimental	7	< 0,3	Low	17,5 %	100 %
40	28	0,3 – 0,7	Medium		
	5	0,7	Hight	82,5%	

Based on Table 1, the N-Gain test results show that the discussion method assisted with wordwall media proved effective. In the experimental class, 82.5% of students demonstrated significant improvement in learning outcomes in the medium to high category, far exceeding the control class, which only reached 31.25%.

Table 2. Students' Achievement on Minimum Mastery Criteria

KKM : 70		Category		Percentage Achieved	
		Achieved	Not Achieved	Achieved	Not Achieved
Control	Pretest	21	25	21,875%	78,125%
32	Posttest	14	18	43,75%	56,25%
Experimental	Pretest	7	33	17,5%	82,5%
40	Posttest	30	10	75%	25%

Table 2, the discussion method assisted with wordwall media also proved effective in achieving the Minimum Mastery Criteria (KKM). At least 75% of students in the experimental class successfully achieved the minimum score of 70, while only 43.75% of students in the control class met the criterion. This indicates that the lecture method was less effective in improving student learning outcomes compared to the discussion method supported with wordwall.

Questionnaire

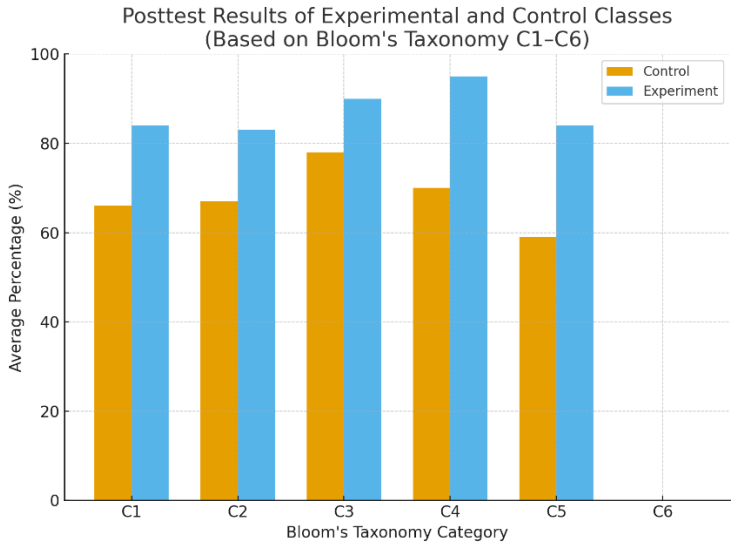
Table 3. Results of Student Response Questionnaire

Category	Number Of Item	Number Of Students	Mean Score	Percentage
Good	15	72	4,01	74%

Table 3 shows that students' responses to the discussion method assisted with wordwall media fell into the "Good" category, with a positive response rate of 74%. This meets the effectiveness criterion, which requires at least 70% of students to respond positively. Thus, the method is not only effective in improving learning outcomes but also well-received by students.

Cognitive Achievement Analysis Based On Bloom's Taxonomy

To further examine the effectiveness of the discussion method assisted with wordwall media, students' posttest scores were analyzed according to the cognitive domains of Bloom's Taxonomy. The posttest consisted of 20 items mapped across levels C1–C6 (remembering, understanding, applying, analyzing, evaluating, and creating). This analysis highlights differences in students' abilities at each cognitive level and provides insights into the strengths and weaknesses of the implemented learning strategy, as well as guidance for more effective teaching practices in the future.



Bar Graph of Posttest Results for Experimental and Control Classes

Posttest Results of Experimental and Control Classes

The posttest results show that the experimental class consistently achieved higher learning outcomes than the control class across all levels of Bloom's Taxonomy (C1–C5). The most notable differences appeared in C1 (remembering) and C2 (understanding), indicating that students in the experimental class demonstrated stronger mastery of basic concepts. Furthermore, the advantages at C4 (analyzing) and C5 (evaluating) suggest that their higher-order thinking skills were also more developed. Thus, learning in the experimental class proved more effective than in the control class, as it not only improved basic abilities but also encouraged students to think critically and evaluatively.

Student Learning Outcomes Using the Discussion Method Assisted with Wordwall

The findings reveal that applying the discussion method assisted with wordwall significantly improved students' learning outcomes. N-Gain analysis showed that 82.5% of students in the experimental class fell within the medium-to-high category, while only 31.25% of students in the control class reached the same level. This proves that the discussion method was more effective than lectures, as it actively engaged students in understanding the material. These results align with Yusuf and Widyaningsih (2021), who emphasized that discussion enhances student interaction and conceptual understanding more effectively than passive learning.

Learning mastery also showed a clear difference. As many as 75% of students in the experimental class achieved the Minimum Mastery Criteria (KKM = 70), far higher than the 43.75% in the control class. This suggests that the discussion method supported with wordwall helped students gain deeper understanding through questioning, sharing ideas, and engaging in interactive exercises. Fitriani and Rachmadyanti (2021) argue that active student participation in discussions strengthens memory and understanding through elaboration processes.

The success of the discussion method assisted with wordwall was also evident in students' responses. Questionnaire results indicated that 74% of students gave positive feedback, rating the learning experience as more interesting and enjoyable. Wordwall provides interactive quiz games that stimulate students' enthusiasm. Supriani and Darmawan (2022) similarly reported that game-based educational media foster students' intrinsic motivation, which in turn improves learning outcomes. Furthermore, integrating wordwall into discussions allowed students not only to recall information but also to connect it with real learning experiences. This supports the constructivist principle of knowledge construction through social interaction and reflection (Arends, 2012).

In the context of the human musculoskeletal system, the discussion method supported with wordwall helped students concretely understand abstract concepts related to bones, muscles, and joints. This finding aligns with Rahmawati et al. (2021), who demonstrated that interactive visual media enhance comprehension of complex biological concepts. Moreover, the discussion approach contributed to the development of critical thinking, as students were encouraged to assess the accuracy of peers' arguments.

This echoes Sarkol et al. (2023), who found that group discussions improve analytical and evaluative skills essential in science learning.

In summary, the integration of the discussion method with wordwall media improved both cognitive and affective outcomes. This strategy was effective because it aligned with constructivist principles, enabling knowledge construction through social interaction, exploration, and collaborative problem-solving.

Cognitive Achievement Analysis Based on Bloom's Taxonomy

The posttest results analyzed according to Bloom's Taxonomy (C1–C6) showed that the experimental class achieved higher cognitive performance than the control class. The bar chart illustrates that in C1 (remembering), the experimental class reached an average of 84%, compared to only 66% in the control class. This indicates that the discussion method assisted with wordwall effectively enhanced students' ability to recall biological concepts. This supports Astuti et al. (2019), who highlighted that verbal interaction and repetition in discussions strengthen memory retention.

In C2 (understanding), experimental students also performed better (83%) than control students (67%), showing that some learners in the control group still struggled to explain concepts in their own words. Discussion encouraged students to articulate ideas in their own language, while wordwall reinforced comprehension through quiz-based exercises. Novitasari and Yuliani (2020) noted that conceptual understanding is better achieved when learners actively reflect and discuss material.

For C3 (applying), the experimental class achieved 90%, compared to 78% in the control class. This reflects the effectiveness of discussions in helping students apply concepts in new contexts. However, some students still found it challenging to connect theory with real-life applications. This finding is consistent with Sudjana and Ibrahim (2018), who argued that discussion promotes students' ability to apply theoretical knowledge to problem-solving.

The highest achievement was observed in C4 (analyzing), where the experimental class reached 95%, far surpassing the control class (70%). Analytical skills, which require higher-order thinking, are rarely developed in conventional teaching. Discussion created opportunities for students to dissect problems, identify relationships among concepts, and evaluate arguments. Halimah et al. (2021) similarly found that discussions are effective in developing analytical skills because they foster questioning and perspective-sharing.

In C5 (evaluating), the experimental class again outperformed the control class, scoring 84% compared to 59%. Discussions trained students to assess peers' arguments, while wordwall provided a platform for testing answer consistency. Facione (2015) emphasized that evaluation is a core element of critical thinking that can be cultivated through group interaction.

Although C6 (creating) was not fully measured by the instruments, classroom observations revealed that experimental students demonstrated creativity by generating new questions and discussion scenarios about the musculoskeletal system. Yuliani et al. (2022) support this finding, noting that discussions encourage creativity by prompting learners to generate innovative solutions.

Overall, the experimental class achieved more balanced improvement across all cognitive levels than the control class. This confirms that the discussion method assisted with wordwall supports tiered learning according to Bloom's Taxonomy, from remembering to evaluating. These results align with Anderson and Krathwohl (2016), who stressed the importance of active strategies in cultivating higher-order thinking skills.

Learning Based on Constructivist Theory

The implementation of the discussion method supported with wordwall aligns with constructivist theory, which emphasizes that knowledge is built through social interaction and active learning. Students did not merely receive information from the teacher but developed understanding through discussions and exploration. Piaget underscored the importance of independent learning and social interaction in cognitive development (Suparno, 2015). Through discussion, students asked questions, shared answers, and compared arguments, leading to meaningful knowledge construction. Wordwall reinforced this process by providing game-based activities that fostered full engagement. Darmawan and Kusuma (2019) also showed that discussion strategies supported by technology enable deeper knowledge construction.

Constructivism emphasizes contextual learning, where success depends on students' involvement in making meaning. In this study, discussions helped students link biology concepts to real-life experiences, such as connecting muscular systems to sports activities. Sari et al. (2021) also reported that constructivist-based learning improves the relevance of concepts to daily life. The teacher's role in this approach was that of a facilitator rather than a knowledge transmitter. As Hidayati et al. (2020) found, the facilitator role encourages student independence.

Wordwall also reflected principles of active learning, as students solved interactive tasks within group discussions rather than passively receiving information. Mustofa and Fajriyah (2022) showed that

interactive digital media enhance constructivist learning by stimulating both cognitive and emotional involvement. Group discussions further promoted collaborative learning, where students shared knowledge and built collective understanding. Vygotsky's concept of the zone of proximal development (ZPD) supports this, as social interaction helps learners achieve higher levels of understanding (Nugroho & Putra, 2017).

Beyond cognitive skills, constructivist-based discussions also improved students' social abilities. They learned to respect others' opinions, negotiate, and build shared conclusions. Fitriyani et al. (2020) confirmed that discussions enhance both social skills and conceptual understanding.Thus, the discussion method assisted with wordwall embodies key constructivist principles: active learners, teachers as facilitators, contextual learning, and social collaboration. This model effectively enhanced learning outcomes as well as critical and social skills.

Implications for the Human Musculoskeletal System Topic

The musculoskeletal system is one of the most complex biology topics, as it involves bones, muscles, and joints and their functions. The discussion method assisted with Wordwall effectively helped students understand these abstract concepts more concretely. Rahmawati et al. (2021) found that interactive media facilitate comprehension of conceptual biology topics. The practical implication was visible in students' improved understanding of skeletal structures. Through discussion, they could explain differences between long, short, and flat bones and connect them with their bodily functions. Wordwall further reinforced this knowledge with image-based exercises. Putri and Nugraha (2022) reported that visual media enhance mastery of anatomical concepts.

For the muscular system, discussions helped students understand antagonistic and synergistic muscle functions through real-life examples such as walking or lifting objects. Wordwall simulations strengthened these concepts interactively. Fadilah et al. (2019) highlighted that combining real experiences with digital media strengthens biology learning. In understanding joint mechanisms, students identified joint types and related them to bodily movements through questioning and answering activities. This aligns with Marlina and Yulianti (2020), who emphasized the role of contextual discussion in strengthening functional understanding.

Moreover, discussions encouraged students to connect musculoskeletal learning with health issues such as osteoporosis and muscle injuries. Students could evaluate causes and propose simple solutions, reflecting mastery of C4 and C5 skills. Halimah et al. (2021) also showed that group discussions enhance critical evaluation in science contexts. Wordwall contributed by maintaining students' motivation through game-based quizzes. Supriani and Darmawan (2022) confirmed that wordwall increases motivation and biology learning outcomes. Collaborative skills also improved, as students worked together to understand complex concepts. Yuliani and Rahayu (2019) reported that group discussions enhance collective understanding through collaboration. Thus, applying the discussion method with wordwall media to musculoskeletal topics positively impacted conceptual comprehension, critical thinking, motivation, and collaboration.

Implementation Process of the Discussion Method Assisted with Wordwall

The musculoskeletal system is one of the most complex biology topics, as it involves bones, muscles, and joints and their functions. The discussion method assisted with wordwall effectively helped students understand these abstract concepts more concretely. Rahmawati et al. (2021) found that interactive media facilitate comprehension of conceptual biology topics. The practical implication was visible in students' improved understanding of skeletal structures. Through discussion, they could explain differences between long, short, and flat bones and connect them with their bodily functions. Wordwall further reinforced this knowledge with image-based exercises. Putri and Nugraha (2022) reported that visual media enhance mastery of anatomical concepts.

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Implementation Process of the Discussion Method Assisted with Wordwall

The implementation process followed structured stages. The teacher began with greetings, attendance, and stimulating questions to spark curiosity. Ice-breaking activities were included to create a positive classroom atmosphere and prevent boredom. Yuliani (2020) found that ice-breaking increases motivation and focus in science learning. This stage provided the emotional and cognitive foundation before the core lesson.

Next, students took a pretest to measure prior knowledge of the musculoskeletal system. This not only assessed their baseline ability but also helped the teacher adjust the discussion strategy to their needs. Arifin (2019) emphasized that pretests in biology are essential for aligning teaching with students' cognitive gaps. Students were then divided into small groups according to subtopics. Collaborative learning reflects Vygotsky's social constructivism, which highlights the role of interaction in shaping understanding (Santrock, 2018). Group discussions allowed students to express ideas, test arguments, and collectively deepen their biology knowledge.

In the exploration phase, the teacher presented an instructional video about skeletal structures and functions. Visual media helped students grasp abstract content, consistent with Prastowo (2021), who found that biology videos enhance cognitive engagement. The teacher supplemented the video with brief explanations to reinforce understanding. Students were introduced to wordwall, where each group created interactive questions based on their assigned subtopic. This activity turned students into co-creators of learning resources. Fitriani and Rachmadyanti (2021) showed that designing digital tasks enhances participation and reflective learning.

Groups presented their wordwall questions to the class, while others answered them. This created both competitive and collaborative dynamics. Indriani (2022) demonstrated that game-based discussions increase intrinsic motivation and conceptual understanding.To boost motivation, the teacher rewarded the highest-scoring group. Deci and Ryan's (2017) Self-Determination Theory explains that recognition sustains intrinsic motivation through positive reinforcement.

Finally, the session closed with reflection, clarification, and concept consolidation. A posttest and student response questionnaire followed. Zainuddin (2020) stressed the importance of reflection in allowing students to reassess their learning and develop independent strategies. Overall, the implementation process integrated cognitive, affective, and social dimensions into a cohesive learning sequence. This shows that the discussion method supported with wordwall effectively fostered holistic learning.

CONCLUSION

Based on the findings, the discussion method assisted with wordwall media is effective in improving senior high school students' learning outcomes on the Human Movement System topic. This is evidenced by 75% of students in the experimental class achieving scores above the minimum mastery criteria, N-Gain results falling within the medium to high category (≥80%), and student questionnaires indicating positive responses in the good category (74%). Therefore, this model is feasible to be implemented as an effective learning strategy.

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