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Development of Mathematics Learning Media Using Wordwall to Improve Students' Interest and Learning Outcomes

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ABSTRACT

This study addresses the limited use of technology-based instructional media and insufficient instructional time in mathematics learning. It aims to develop and evaluate Wordwall-based learning media in terms of validity, practicality, and effectiveness in improving students' learning interest and achievement. The study employed a Research and Development design using the ADDIE model up to the evaluation stage. Participants included 32 eighth-grade students from SMP Negeri 3 Huruna and one mathematics teacher. Data were collected through expert validation involving three validators, student and teacher response questionnaires, and learning achievement tests. Data analysis combined descriptive qualitative analysis with quantitative analysis using percentage scores and pretest–posttest comparisons. The findings indicate that the developed media is valid in terms of content, language, and visual design; highly practical, as reflected by positive responses from more than 90 percent of students and teachers; and effective in improving learning interest, with an average increase of 25 percent, as well as learning outcomes, with an N-gain of 0.62 in the medium–high category. The novelty of this study lies in positioning Wordwall not merely as a gamification tool, but as an interactive learning medium systematically integrated within the ADDIE instructional design framework for mathematics learning. Theoretically, this study strengthens evidence on the role of gamification within instructional design. Practically, it offers teachers a viable strategy to address time constraints while enhancing student engagement and learning outcomes..

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Introduction

Mathematics plays a fundamental role in developing students' logical, critical, and systematic thinking skills (OECD, 2018). As a structured and hierarchical discipline, mathematics requires strong conceptual interconnectedness. Difficulties in understanding one concept often hinder the comprehension of subsequent topics (Jankvist & Niss, 2020). These abstract characteristics frequently pose challenges for students, particularly when instruction is delivered without contextual and engaging approaches (Mesa et al., 2021; Moore et al., 2024). Such conditions contribute to low academic achievement and highlight the need for innovative instructional strategies and learning media that facilitate conceptual understanding while enhancing students' motivation to learn mathematics (Martínez et al., 2020; Nehls et al., 2020; Thanheiser & Melhuish, 2023).

Learning interest is a key internal factor influencing students' success in mathematics. High learning interest promotes focus, persistence, and active engagement, which positively affect conceptual understanding and learning outcomes (Velani & Retnawati, 2020). In contrast, low learning interest reduces intrinsic motivation and engagement, ultimately leading to poorer academic performance (Apolonia Hendrice Ramda et al., 2023; Kosiol et al., 2019). Empirical evidence indicates that learning interest encompasses not only cognitive aspects but also affective dimensions related to students' learning experiences and attitudes (Agterberg et al., 2022). Therefore, fostering students' interest in mathematics, a subject often perceived as difficult, is essential for promoting active participation and improved learning outcomes. However, existing data indicate that students' interest in mathematics remains at a moderate level, suggesting the need for more effective instructional strategies.

At SMP Negeri 3 Huruna, students' mathematics learning interest and achievement remain suboptimal. Mid-semester evaluation data for the 2023/2024 academic year show that the average score of grade VIII students was 56.78, below the Learning Goal Completeness Criteria of 65. Additionally, the average score from the learning interest questionnaire was 65, categorized as sufficient. These findings indicate limited student motivation and engagement in mathematics learning, which directly affects learning outcomes. This situation is further exacerbated by the limited use of technology-based instructional media, resulting in monotonous learning experiences that fail to attract students' interest.

One potential solution to address low learning interest and achievement is the integration of interactive technology-based learning media. Wordwall, a digital gamification platform, provides various quiz-based activities such as matching, spinning, and interactive games that can be adapted to mathematical content (Kärki et al., 2022; Nisa & Susanto, 2022). Wordwall facilitates a learning environment that is engaging, competitive, and participatory while offering immediate feedback to students. These features position Wordwall not only as an assessment tool but also as an interactive instructional medium capable of stimulating curiosity and increasing student engagement. Based on this potential, this study focuses on developing Wordwall-based mathematics learning media using the ADDIE model and evaluating its validity, practicality, and effectiveness in improving students' learning interest and outcomes.

Previous studies have demonstrated the effectiveness of Wordwall in enhancing student motivation and learning outcomes through gamified quiz-based activities (Angeliki Kolovou et al., 2013; Clark-Wilson et al., 2020; Kärki et al., 2022; Swidan et al., 2022). However, existing research predominantly positions Wordwall as an evaluation tool rather than integrating it systematically into comprehensive instructional design. This gap highlights the need for studies that examine Wordwall as an integral component of the learning process, not merely as an assessment instrument, but as a medium that actively supports learning and fosters sustained student interest and achievement. Based on these conditions, several problems in mathematics

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learning at SMP Negeri 3 Huruna can be identified. First, students' learning interest remains moderate, limiting their active engagement in the learning process. Second, instructional practices tend to rely on conventional approaches that lack variation and fail to motivate students. Third, the use of technology-based learning media is minimal, despite its potential to create interactive learning environments. Fourth, students' low learning outcomes indicate that existing instructional practices are insufficient to achieve learning objectives. These issues underscore the need to develop mathematics learning media that are valid, practical, and effective in enhancing students' interest and achievement.

To maintain focus, this study applies several limitations. The research was conducted with grade VIII students at SMP Negeri 3 Huruna during the 2023/2024 academic year. The learning media developed were limited to the use of the Wordwall application for mathematics instruction. The study specifically examined students' learning interest and learning outcomes as indicators of effectiveness. These limitations guided the formulation of research questions addressing the validity, practicality, and effectiveness of the developed learning media. Accordingly, this study aims to develop mathematics learning media that respond to contemporary instructional challenges. The research seeks to produce learning media that meet validity, practicality, and effectiveness criteria while creating engaging and meaningful learning experiences. By systematically integrating Wordwall within the ADDIE development framework, this study positions Wordwall not merely as an evaluation tool but as an interactive instructional medium that promotes active student involvement. The findings are expected to contribute to the literature on gamification-based mathematics learning and provide practicl guidance for teachers in designing more varied and relevant learning experiences aligned with current educational demands.

Method

Type of Research

This study employed a Research and Development (R&D) approach aimed at producing Wordwall-based mathematics learning media and evaluating its validity, practicality, and effectiveness. The development process followed the ADDIE model, which consists of five stages: analysis, design, development, implementation, and evaluation. This model was selected due to its systematic structure, flexibility, and suitability for developing instructional products that can be adapted to students' and teachers' needs. The developed media focused on linear function topics for grade VIII junior high school students. To examine effectiveness, a one-group pretest–posttest design was applied to measure changes in students' learning outcomes before and after the intervention. Effectiveness analysis was supported by inferential statistical procedures, including normality testing, paired t-test or Wilcoxon test, N-gain calculation, and effect size estimation using Cohen's d

Population and Sample

The population of this study comprised all grade VIII students of SMP Negeri 3 Huruna during the 2023/2024 academic year. The sample was selected purposively based on class homogeneity, school readiness, and teachers' willingness to collaborate. The study involved 26 grade VIII students as the primary participants, with an average age of 13–14 years, consisting of 14 female and 12 male students. In addition, one mathematics teacher participated as an additional respondent. Students were involved in providing responses related to the practicality of the learning media and completing learning outcome tests, while the teacher assessed the practicality of the media in terms of instructional implementation. The sample size was

determined in accordance with the contextual limitations of Research and Development studies. Considerations related to external validity are addressed in the limitations section..

Instruments

The study employed four types of research instruments. First, expert validation instruments were used to assess content, language, and media aspects. The content validation instrument consisted of 10 items evaluating alignment with basic competencies, conceptual accuracy, and presentation feasibility. The language validation instrument included 8 items assessing linguistic accuracy, sentence clarity, and appropriateness for students' developmental levels. The media validation instrument comprised 12 items evaluating visual appearance, readability, design consistency, and the extent to which Wordwall features support independent learning. Three validators were involved, and validation results were analyzed using Aiken's V coefficient with a 95% confidence interval and an acceptance threshold of ≥ 0.80. Second, a mathematics learning interest questionnaire consisting of 15 statements on a five-point Likert scale (1 = strongly disagree to 5 = strongly agree) was administered. The questionnaire measured students' enjoyment, attention, and interest in learning mathematics. The reliability of this instrument was confirmed with a Cronbach's Alpha coefficient of 0.87, indicating high internal consistency.

Third, student and teacher response questionnaires were used to evaluate the practicality of the developed media. The student questionnaire consisted of 12 items, while the teacher questionnaire included 10 items. Reliability for both instruments was calculated using Cronbach's Alpha and met acceptable reliability criteria. Fourth, learning outcomes were measured using a test consisting of 10 constructed-response items on linear function material. The test items were examined prior to implementation to ensure item validity, reliability, discrimination power, and appropriate difficulty levels. Scoring was conducted using an analytical rubric, and two independent raters were involved. Inter-rater reliability was assessed using the Intraclass Correlation Coefficient to ensure scoring consistency. Overall content validity of the instruments, as evaluated by experts, yielded Aiken's V coefficients ranging from 0.80 to 0.92, indicating that the instruments were appropriate for use.

Procedures

The research procedure followed the ADDIE development framework. During the analysis stage, classroom observations were conducted, interviews with the school principal and mathematics teachers were carried out, and a learning interest questionnaire was administered to students. The analysis results indicated low levels of student interest and mathematics learning outcomes, along with limited use of technology-based instructional media. In the design stage, Wordwall-based learning media were designed in alignment with basic competencies. This stage involved structuring linear function materials, developing interactive activities in the form of quizzes and game-based assessments, and preparing research instruments. During the development stage, the learning media were created using the Wordwall platform and subsequently validated by content, language, and media experts. Revisions were implemented based on expert feedback until the media met the established eligibility criteria.

The implementation stage consisted of a field trial involving grade VIII students. The developed media were integrated into classroom instruction, during which students provided responses related to the practicality of the media, and the teacher conducted additional evaluations of its implementation. The trial was conducted across four instructional meetings of 3 × 40 minutes, with different Wordwall activity formats used in each meeting, such as

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match-up, quiz, and open-the-box activities. Prior to implementation, brief training was provided to the teacher to ensure effective use of the media. Implementation fidelity was monitored using a checklist, with a minimum implementation threshold of 80 percent. At the evaluation stage, formative evaluation was conducted through analysis of expert validation results, student and teacher response data, and learning outcome test scores. This evaluation aimed to determine whether the developed media met the criteria of validity, practicality, and effectiveness. Effectiveness evaluation also included comparisons of pretest and posttest scores, as well as analysis of changes in students' learning interest scores.

Data Analysis

The research data comprised qualitative and quantitative data. Qualitative data, including validators' comments and suggestions as well as observation notes, were analyzed descriptively to inform revisions and improvement of the developed media. Quantitative data, consisting of questionnaire scores and learning outcome test results, were analyzed using percentage-based techniques. The media were considered valid if the expert validation score exceeded 60 percent, practical if student and teacher response scores exceeded 75 percent, and effective if at least 60 percent of students achieved a score of ≥ 65 based on the Learning Objective Completeness Criteria. Effectiveness analysis was further supported by inferential statistical procedures, including the Shapiro–Wilk normality test, paired t-test for normally distributed data or Wilcoxon signed-rank test for non-normal data, N-gain calculation, and effect size estimation using Cohen's d. Changes in students' learning interest were examined through pretest–posttest comparisons and corresponding effect measures. All quantitative analyses were conducted using SPSS version 25 to compute descriptive statistics, instrument reliability coefficients, and percentages related to validation results, response data, and learning completeness.

This study received formal approval from the school, including research permission and authorization from the principal and mathematics teachers. Student participation was voluntary and conducted with parental or guardian consent, and the confidentiality of students' personal data was ensured. All data were used exclusively for academic and research purposes and were stored securely on encrypted media in accordance with institutional data retention policies. Ethical approval from the institutional educational research ethics committee was obtained or deemed not required by the institution. All research procedures adhered to ethical principles in educational research, including respect for participants' rights, protection of confidentiality, and avoidance of any adverse effects arising from participation.

Research Findings

This section presents the main findings of the research on the development of Wordwall-based mathematics learning media in grade VIII students of SMP Negeri 3 Huruna. The results of the research are presented systematically in accordance with the stages of the ADDIE model which include analysis, design, development, implementation, and evaluation. The data presented included expert validation results (materials, language, and media), practicality tests (student and teacher responses), and effectiveness tests (students' interests and learning outcomes). These findings not only provide an overview of the feasibility of the developed product, but also show the real contribution of Wordwall in improving the quality of mathematics learning.

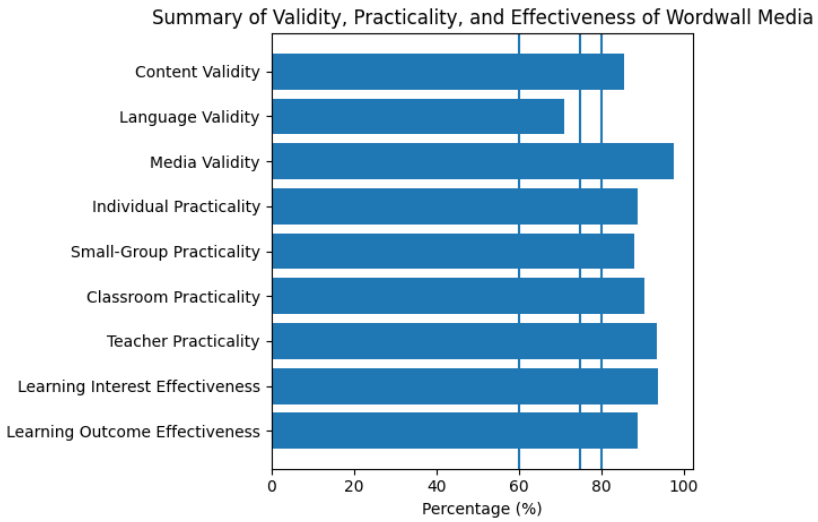

Figure 1. Summary of validity, practicality, and effectiveness

Validity of Learning Media

The validation results showed that Wordwall-based learning media met valid criteria. The subject matter expert gave a final score of 87% (very valid category) after going through two revisions, indicating that the suitability of the material with basic competencies and the accuracy of the concept has been met. Media experts gave a higher score, namely 97.5% (a very valid category), which confirms that the appearance, readability, and interactivity of the media strongly support the learning process. However, the results of the linguist validation obtained a score of 71.1% (valid category), so even though the media was declared suitable for use, the language aspect still needed further improvement, especially in the selection of vocabulary and clarity of instruction to be more in line with the level of student development.

Practicality of Learning Media

The practicality of the media was measured through the responses of students and teachers at various stages of the trial. Individual, small group, and field trials consistently showed an average score above 88%, while teacher responses reached 93.6%, all of which were categorized as practical to very practical. This proves that Wordwall is easy to use, time-efficient, and able to actively increase student engagement. These findings also show that media can be applied in both classical and independent learning, and provide a fun and varied learning experience for students.

Effectiveness of Learning Media

The effectiveness of media is analyzed from two aspects: learning interest and student learning outcomes. The results of the questionnaire showed that students' learning interest reached 93.84% with the very good category, which means that Wordwall is able to arouse students' enthusiasm, attention, and interest in learning mathematics. In terms of learning outcomes, there was a significant increase from the average initial test score of 74 (effective category) to the average final test score of 89 (very effective category). The classical completeness percentage reached 89.28%, exceeding the minimum completeness standard of 65%, so it can be concluded that Wordwall not only increases interest, but also has a real impact on the achievement of student learning outcomes. Inferential analysis supported these findings, with the results of *the paired t-test* showing a significant difference between pretest and posttest

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scores (t(25)=7.84, p<0.001). The magnitude effect (Cohen's d=1.25) is in the high category, which signifies a substantial increase. The average N-gain obtained was 0.62 (medium–high category), reinforcing the evidence that Wordwall is effective in improving students' academic achievement. In terms of learning interest, the pre-post analysis also showed a significant increase (Z=-4.12, p<0.001) with an effect of r=0.65 (large category), confirming that Wordwall is able to increase student motivation and involvement in learning

Overall, the results of this study show that Wordwall-based learning media has high validity, excellent practicality, and significant effectiveness in supporting mathematics learning. Although the language aspect still needs improvement, this media has proven to make a positive contribution to improving the quality of learning by presenting a more interactive, competitive, and fun learning experience. The summary of the findings is presented in Table 1

Table 1. Summary of Research Findings

Aspects	Indicators/Data Sources	Percentage	Categories	Interpretation
Validity	Material Expert	87%	Highly Valid	The material is KD-compliant, accurate, and relevant; Suitable for use after revision.
	Linguist	71,1%	Valid	The language is quite clear, but it needs refinement on vocabulary & instructions.
	Media Member	97,5%	Highly Valid	Media display, design, and interactivity strongly support learning.
Practicality	Individual Tests (3 students)	88,8%	Practical	Media is easy to use and engaging on an individual level.
	Small Group Test (6 students)	88%	Practical	Students are actively engaged, the media is accessible and varied.
	Field Tests (26 students)	90,4%	Very Practical	The positive response of the majority of students, an effective medium for classical learning.
	Math Teacher Test	93,6%	Very Practical	Teachers assess the media to be efficient, interactive, and support learning outcomes.
Effectiveness	Interest in Learning (Questionnaire)	93,84%	Excellent	Wordwall increases student motivation, attention, and interest.
	Learning Outcomes (Final Test)	89%	Highly Effective	There was a significant increase from the initial test (74 → 89); complete achievement.
	Classical Completeness	89,28%	Highly Effective	More than 80% of students achieved KKM (65), meeting the classical success criteria.

Based on Table 1, the results of the study show that in terms of validity, Wordwall-based learning media obtained an excellent assessment. In addition to percentage, statistical analysis showed the consistency of the findings: the validity of the instrument was verified with Aiken's V in the range of 0.80–0.92 (feasible), the practicality of the questionnaire had a reliability of α>0.85 (high category), and the effectiveness of learning outcomes was supported by N-gain and a strong magnitude effect. Validation by subject matter experts (87%) and media experts (97.5%) is in the very valid category, which indicates that the content, display, and design of the media are in accordance with the mathematics learning standards so that they can be used without major revisions. However, linguist validation only reached 71.1% with the valid category, which means that the language aspect still needs improvement, especially in sentence

clarity and vocabulary suitability with students' level of development. This is an important note so that the media is more optimal communicatively.

From the practical aspect, the results of individual trials (88.8%), small groups (88%), field (90.4%), and teachers (93.6%) all showed the category of practical to very practical. The increase in scores on field tests and teachers shows that the media is not only well received by students, but is also considered easy and effective to use by teachers in teaching practice. These findings confirm that Wordwall has strong implementation potential in the context of real learning in the classroom.

Meanwhile, in the aspect of effectiveness, the results of the study showed very positive achievements. Student learning interest reached 93.84% with the excellent category, which indicates that gamification integration through Wordwall has succeeded in arousing students' enthusiasm and motivation in learning mathematics. In addition, the average learning outcomes (89%) and classical completeness (89.28%) were also in the very effective category. Thus, this media not only succeeds in attracting students' interest, but also has a real impact in improving their academic achievement.

To provide a more concise and comprehensive picture of the research achievements, the results of the validity, practicality, and effectiveness of Wordwall-based learning media are summarized in Table 2. Table 2 presents the percentage of results, assessment categories, and interpretations and follow-up recommendations.

Table 2. Outcomes, assessment categories, and interpretation and follow-up recommendations

Appearance	Result (%)	Category	Interpretation & Recommendation
Validity	Subject: 87% Language: 71.1% Medium: 97.5%	Material: Very Valid Language: Valid Media: Very Valid	The media is worth using. The language aspect still needs revision to clarify sentences and adjust vocabulary to student development.
Practicality	Individuals: 88.8% Small groups: 88% Field: 90.4% Teachers: 93.6%	Practical – Very Practical	The media is easy to use, accepted by both students and teachers. Recommended for wider implementation in real classes.
Effectiveness	Interest: 93.84% Learning Outcomes: 89% Classical Completeness: 89.28%	Highly Effective	The media significantly increases students' interest in learning and academic outcomes. It is recommended to extend its use to other math topics.

Table 2 shows that the validity of the media has met the criteria very well in the aspects of material (87%) and media (97.5%), so that the content and visual design are declared ready for use. However, in the language aspect (71.1%), although it is considered valid, there is still a need for revision, especially in sentence clarity and vocabulary selection to be more in line with student development. In terms of practicality, the results of the trial both on the scale of individuals, small groups, field, and teachers showed percentages ranging from 88% to 93.6% with the category of practical to very practical. This confirms that media can be used easily, well received by students, and considered effective by teachers in supporting the learning process in real classrooms. Furthermore, in terms of effectiveness, Wordwall has been proven

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to be able to increase students' interest in learning (93.84%, very good category) while having a positive impact on academic learning outcomes (89%) with a classical completeness rate of 89.28% (very effective category). These findings show that the integration of gamification in mathematics learning not only increases student motivation, but also contributes significantly to the achievement of academic outcomes.

The findings of this study show that Wordwall-based learning media is feasible to be used in supporting mathematics learning in junior high school. From the aspect of validity, the media has met good criteria in terms of suitability of material and appearance, although the language aspect still needs improvement to be more communicative and in accordance with the level of student development. In terms of practicality, this media is seen as easy to use, can be integrated into the learning process, and is well received by teachers and students. Meanwhile, in terms of effectiveness, Wordwall has been proven to be able to increase students' interest in learning while having a positive impact on their learning outcomes. Thus, Wordwall not only functions as an evaluation medium, but also as an interactive learning tool that is able to present a more interesting, participatory, and meaningful learning atmosphere in mathematics learning. All of these results are consistent with quantitative analysis that shows a significant difference between pre-post-learning, with moderate-high N-gain and large magnitude effects, so that the effectiveness of Wordwall can be said to be statistically and practically strong.

Discussion

This study demonstrates that Wordwall-based learning media meet the criteria of validity, practicality, and effectiveness in supporting junior high school mathematics learning. High validity in the material and media aspects indicates that the developed content and visual design align with instructional standards and are suitable for direct classroom use. However, language validity was categorized only as valid rather than highly valid, suggesting that instructions and vocabulary selection require refinement to better align with students' cognitive development levels. This finding is consistent with Kärki et al. (2022) and Nisa & Susanto (2022), who emphasize that linguistic clarity in digital learning media is critical for ensuring student comprehension. Therefore, improving linguistic aspects remains a priority for enhancing overall media quality.

In terms of practicality, Wordwall was positively received by both teachers and students. Teachers perceived the media as easy to use and effective in addressing limited instructional time, while students reported more engaging and enjoyable learning experiences due to the interactive and challenge-based features. These findings support Clark-Wilson et al. (2020), Günster & Weigand (2020), and Swidan et al. (2022), who reported that gamification-based digital media are flexible across classroom contexts and reduce the monotony of conventional instruction. The results further indicate that the integration of simple yet relevant technologies such as Wordwall can address the demands of 21st-century learning environments.

The effectiveness of Wordwall is reflected in increased student motivation and improved academic achievement. These findings align with Self-Determination Theory (Regier & Savic, 2020; Street et al., 2022), which posits that gamification elements such as structured challenges, immediate feedback, and healthy competition foster intrinsic motivation. Empirically, the results are consistent with studies by Rubio et al. (2022), who identified a positive relationship between intrinsic motivation and academic achievement, and Hsieh et al. (2025), who demonstrated the effectiveness of interactive technology in strengthening mathematical understanding. These findings suggest that Wordwall functions not only as an evaluation tool but also as an instructional medium that promotes active participation, emotional engagement, and conceptual understanding.

Despite these positive outcomes, this study has several limitations. First, the developed media focused solely on linear function topics, limiting generalizability to other mathematical domains with different conceptual characteristics. Second, the sample was restricted to a single school with a relatively small number of participants, which constrains external validity. Third, effectiveness was assessed only in the short term, and long-term impacts on motivational sustainability and academic performance were not examined. Technical constraints, including dependence on stable internet access and feature limitations in the free version of Wordwall, may also affect implementation, particularly in low-resource schools. In addition, the absence of a control group limits internal validity, as improvements in learning outcomes may be influenced by factors beyond the intervention. These limitations should be addressed in future studies.

From a theoretical perspective, the findings reinforce the constructivist view of digital learning (Hackenberg et al., 2021; Wilkie, 2020), which emphasizes interactive learning experiences as a means of supporting conceptual construction. This study contributes to the literature by demonstrating that Wordwall can function beyond evaluation purposes, serving as an interactive learning medium that facilitates competitive, collaborative, and meaningful student engagement. Moreover, the findings extend gamification research by highlighting the distinctive potential of Wordwall, compared with platforms such as Kahoot and Quizizz, in integrating formative assessment with interactive learning activities. Practically, Wordwall offers teachers a viable instructional alternative to enhance student motivation and learning outcomes. For schools, the adoption of gamification-based digital media represents a strategic approach to improving mathematics instruction in digitally oriented learning environments.

From an educational policy perspective, these findings have important implications at both school and national levels. Integrating gamification into the mathematics curriculum may serve as an effective strategy to address students' low interest in mathematics. Teacher professional development programs should place greater emphasis on the pedagogical use of accessible gamification tools, including Wordwall, to strengthen teachers' technological competencies. In addition, adequate digital infrastructure support is essential to ensure equitable implementation across diverse educational contexts, particularly in schools with limited resources. Overall, this study indicates that Wordwall-based gamification is relevant to the demands of 21st-century learning and holds potential as an alternative approach to enriching mathematics instruction. By addressing existing limitations and conducting further development, Wordwall may contribute meaningfully to the integration of technology, motivation, and academic achievement in mathematics education. Nevertheless, the findings remain preliminary and warrant further investigation using larger samples, diverse mathematical topics, and more rigorous experimental designs.

Conclusion

This study concludes that Wordwall-based learning media meet the criteria of validity, practicality, and effectiveness for use in junior high school mathematics learning. High validity in the material and media aspects indicates that the developed content and visual design align with instructional standards. However, the language aspect requires further refinement to enhance instructional clarity and ensure vocabulary suitability with students' cognitive development. In terms of practicality, Wordwall is easy to operate, well accepted by both teachers and students, and supports active engagement in the learning process. Regarding effectiveness, the media demonstrates strong potential to enhance students' learning interest and academic achievement. Nevertheless, this effectiveness should be interpreted contextually, as the limited sample size and absence of a comparison group mean that the findings represent

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strong indications rather than conclusive evidence. Accordingly, Wordwall can be positioned not only as an assessment tool but also as an interactive learning medium aligned with the demands of 21st-century education.

From a theoretical perspective, this study reinforces evidence that digital gamification can function as a pedagogical approach that fosters intrinsic motivation and supports deeper conceptual understanding in mathematics learning. Practically, Wordwall offers a simple, flexible, and impactful instructional alternative that can assist teachers and schools in improving learning quality. Policy implications also arise, particularly the need for teacher professional development and adequate digital infrastructure to enable broader integration of Wordwall and similar gamification-based media, in line with the objectives of the Independent Curriculum.

Despite these contributions, this study has several limitations. The learning media were developed exclusively for linear function topics, the sample was limited to a single school with a small number of participants, and effectiveness was measured only in the short term. In addition, the absence of a control group constrains internal validity, while technical factors such as internet stability and feature limitations in the free version of Wordwall may affect implementation in low-resource contexts. Therefore, future research is recommended to: (1) extend the application of Wordwall to a wider range of mathematical topics with greater conceptual complexity; (2) involve larger and more diverse samples to strengthen the generalizability of findings; and (3) conduct longitudinal studies to examine the sustained effects of Wordwall on students' motivation and academic achievement. With further development and rigorous evaluation, Wordwall has the potential to evolve into a gamification-based learning media model adaptable to diverse educational contexts.

Conflict of Interest

The authors declare that there is no conflict of interest.

Authors' Contributions

P.M.A.H. contributed to the development of the research title, formulation of the introductory sentences, and the basic conceptualization of the study. Y.N.T., R.N.M and S.L. actively participated in drafting the manuscript, composing sentences, conducting tests, and performing the research directly at the school. All authors have read and approved the final version of this manuscript. The percentage contributions for conceptualization, drafting, and revising the article are as follows: P.M.A.H.: 70%, Y.N.T.: 10%, R.N.M.: 10%, and S.L.: 10%.

Data Availability Statement

The authors declare that the data supporting the findings of this study will be made available by the corresponding author, P.M.A.H., upon reasonable request.

References

Agterberg, D. A., Oostdam, R. J., & Janssen, F. J. J. M. (2022). From speck to story: relating history of mathematics to the cognitive demand level of tasks. *Educational Studies in Mathematics*, *110*(1), 49–64. https://doi.org/10.1007/s10649-021-10093-6

Angeliki Kolovou, Marja van den Heuvel-Panhuizen, & Olaf Köller. (2013). An Intervention Including an Online Game to Improve Grade 6 Students' Performance in Early Algebra.

Journal for Research in Mathematics Education, *44*(3), 510. https://doi.org/10.5951/jresematheduc.44.3.0510

Apolonia Hendrice Ramda, Ermilinda S Mulia, Fransiskus Nendi, & Gunur, B. (2023). Interest In Learning Mathematics And Contextual Teaching And Learning With Ethnomatematics Content: Mbaru Tembong. *Jurnal Pendidikan Dan Kebudayaan Missio*, *15*(2). https://doi.org/10.36928/jpkm.v15i2.2085

Clark-Wilson, A., Robutti, O., & Thomas, M. (2020). Teaching with digital technology. *ZDM - Mathematics Education*, *52*(7), 1223–1242. https://doi.org/10.1007/s11858-020-01196-0

Günster, S. M., & Weigand, H. G. (2020). Designing digital technology tasks for the development of functional thinking. *ZDM - Mathematics Education*, *52*(7), 1259–1274. https://doi.org/10.1007/s11858-020-01179-1

Hackenberg, A. J., Aydeniz, F., & Jones, R. (2021). Middle school students ' construction of quantitative unknowns ⋆. *Journal of Mathematical Behavior*, *61*(December 2020), 100832. https://doi.org/10.1016/j.jmathb.2020.100832

Hsieh, F. J., Wang, T. Y., Hsieh, C. J., & Chu, C. T. (2025). The relationships of preservice teachers' dispositions and noticing of technology-integrated mathematics teaching activities. *ZDM - Mathematics Education*. https://doi.org/10.1007/s11858-025-01727-7

Jankvist, U. T., & Niss, M. (2020). Upper secondary school students' difficulties with mathematical modelling. *International Journal of Mathematical Education in Science and Technology*, *51*(4), 467–496. https://doi.org/10.1080/0020739X.2019.1587530

Kärki, T., McMullen, J., & Lehtinen, E. (2022). Improving rational number knowledge using the NanoRoboMath digital game. *Educational Studies in Mathematics*, *110*(1), 101–123. https://doi.org/10.1007/s10649-021-10120-6

Kosiol, T., Rach, S., & Ufer, S. (2019). (Which) Mathematics Interest is Important for a Successful Transition to a University Study Program? *International Journal of Science and Mathematics Education*, *17*(7), 1359–1380. https://doi.org/10.1007/s10763-018-9925-8

Martínez, S., Guíñez, F., Zamora, R., Bustos, S., & Rodríguez, B. (2020). On the instructional model of a blended learning program for developing mathematical knowledge for teaching. *ZDM - Mathematics Education*, *52*(5), 877–891. https://doi.org/10.1007/s11858-020-01152-y

Mesa, V., Ma, Y., Quiroz, C., Gerami, S., Liakos, Y., Judson, T., & Chamberlain, L. (2021). University instructors ' use of questioning devices in mathematics textbooks : an instrumental approach. *ZDM – Mathematics Education*, *0123456789*. https://doi.org/10.1007/s11858-021-01296-5

Moore, K. C., Wood, E., Welji, S., Hamilton, M., Waswa, A., Ellis, A. B., & Tasova, H. I. (2024). Using abstraction to analyze instructional tasks and their implementation. *Journal of Mathematical Behavior*, *74*(April), 101153. https://doi.org/10.1016/j.jmathb.2024.101153

Nehls, C., König, J., Kaiser, G., & Blömeke, S. (2020). Profiles of teachers' general pedagogical knowledge: nature, causes and effects on beliefs and instructional quality. *ZDM - Mathematics Education*, *52*(2), 343–357. https://doi.org/10.1007/s11858-019-01102-3

Nisa, M. A., & Susanto, R. (2022). Pengaruh Penggunaan Game Edukasi Berbasis Wordwall Dalam Pembelajaran Matematika Terhadap Motivasi Belajar. *JPGI (Jurnal Penelitian Guru Indonesia)*, *7*(1). https://doi.org/10.29210/022035jpgi0005

OECD. (2018). *Programme for International Students Assesment (PISA) Result From PISA 2018*.

Kognitif: Jurnal Riset HOTS Pendidikan Matematika
https://doi.org/10.51574/kognitif.v5i4.3816 Volume 5, No 4, October - December 2025, pp. 1665 – 1668

Regier, P., & Savic, M. (2020). How teaching to foster mathematical creativity may impact student self-efficacy for proving. *Journal of Mathematical Behavior*, *57*(September 2018), 100720. https://doi.org/10.1016/j.jmathb.2019.100720

Rubio, I. M., Ángel, N. G., Esteban, M. D. P., & Ruiz, N. F. O. (2022). Emotional Intelligence as a Predictor of Motivation, Anxiety and Leadership in Athletes. *International Journal of Environmental Research and Public Health*, *19*(12). https://doi.org/10.3390/ijerph19127521

Street, K. E. S., Malmberg, L. E., & Stylianides, G. J. (2022). Changes in students' self-efficacy when learning a new topic in mathematics: a micro-longitudinal study. *Educational Studies in Mathematics*, *111*(3), 515–541. https://doi.org/10.1007/s10649-022-10165-1

Swidan, O., Bagossi, S., Beltramino, S., & Arzarello, F. (2022). Adaptive instruction strategies to foster covariational reasoning in a digitally rich environment. *Journal of Mathematical Behavior*, *66*. https://doi.org/10.1016/j.jmathb.2022.100961

Thanheiser, E., & Melhuish, K. (2023). Teaching routines and student-centered mathematics instruction: The essential role of conferring to understand student thinking and reasoning. *Journal of Mathematical Behavior*, *70*(December 2022), 101032. https://doi.org/10.1016/j.jmathb.2023.101032

Velani, F. Y., & Retnawati, H. (2020). Application of contextual teaching and learning approaches in improving mathematics interest and learning achievement of elementary school students. *Journal of Physics: Conference Series*, *1511*(1). https://doi.org/10.1088/1742-6596/1511/1/012032

Wilkie, K. J. (2020). Investigating Students' Attention to Covariation Features of their Constructed Graphs in a Figural Pattern Generalisation Context. *International Journal of Science and Mathematics Education*, *18*(2), 315–336. https://doi.org/10.1007/s10763-019-09955-6

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