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1 message

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Enhancing Mathematics Learning in Phase E: Assessing Wordwall Effectiveness

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ABSTRACT

The use of technology, classroom atmosphere, facilities, and learning resources can support quality learning outcomes in students. Wordwall, as a gamification tool, has been proven to be effective for elementary and junior high school students in mathematics. However, the effectiveness of Wordwall in enhancing senior high school students' cognitive abilities in mathematics learning has not been investigated. Previous studies have only shown its effectiveness in improving affective abilities. Therefore, This study endeavors to evaluate the effects of using Wordwall on the mathematics learning outcomes of senior high school students in Phase E. Through quasi-experimental research with pre- and posttest group design, 38 experimental class students and 37 control class students were selected as samples in this study. The study found a statistically significant difference (sig. 0.000<0.05) in the mean learning outcomes of students who used Wordwall compared to those who did not. Descriptively, The experimental group displayed superior average mathematics learning outcomes compared to the control group, demonstrating a moderate level of effectiveness (ES=0.57). The strong effect of Wordwall can be realized if it is used not only as an exercise tool within the classroom but also as an instrument for knowledge transformation, incorporating consideration of students' learning styles.

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1. INTRODUCTION

Science and technology discipline is currently advancing rapidly, influencing various aspects of human life, including education. Since the 1970s, technology has transformed mathematics education and will undoubtedly play a major role in shaping the future of education compared to today. Educators realize the necessity to reconsider the entire education model and redesign it to be more student-centered [1], [2], [3], [4], [5].

Mathematics profoundly influences the attainment of the Sustainable Development Goals (SDGs). Simultaneously, these goals facilitate the exploration of real-life situations within the realm of mathematics, fostering active learning for students [6], [7]. In this context, each learning objective in a mathematics lesson is linked to something meaningful for the students, incorporating aspects of their daily lives [8], [9]. Therefore, mathematics education can genuinely prepare human resources to compete in the global era.

The obtained information reveals that the teaching and learning process lacks integration with technology. Consequently, students experience demotivation due to feelings of monotony and boredom associated with book-based learning and the limited communicative role of teachers. Low motivation leads to

a decline in academic achievement [10], [11], [12]. To improve academic performance, students must consider Psychological aspects such as learning preferences, self-efficacy, and goals for achievement [13], motivation [14], [15], interests [16], and the teaching and learning environment [17], [18].

Academic performance fundamentally encompasses skills related to knowledge, skills, attitudes, and values manifested in habits of thinking and behaving. Experiencing understanding "in action" involves integrating content knowledge and cognitive competencies with the demonstration of perspective, empathy, and self-awareness—qualities collectively termed as professional dispositions [19].

A potential remedy to enhance engagement and motivation in students involves the adoption of gamification. Gamification represents an approach that incorporates game components outside the typical gaming environment [20], [21], [22].

Utilizing virtual gamification platforms like Wordwall.net holds the potential to heighten students' interest in their learning processes [23], [24], [25]. This approach is considered highly suitable for mathematics students, fostering engagement in various learning activities [26], [27]. Wordwall, functioning as an educational technology tool, is intentionally designed to facilitate interactive learning in diverse settings. It empowers both educators and learners to create personalized interactive materials, thereby enriching individual and collaborative learning experiences. These interactive resources are applicable in various pedagogical contexts, including formative assessment and gamified learning.

The Wordwall tool offers a wide array of templates, such as quizzes, matching exercises, word searches, and crossword puzzles, all of which can be customized to meet users' specific needs. Noteworthy characteristics also encompass its accessibility, adaptability, and the potential for collaboration between student and teacher teams [28]. Wordwall is accessible via any web-enabled device, encompassing interactive whiteboards, tablets, desktop and portable computers, or smartphones. Its simplicity makes it user-friendly, facilitating easy operation for average users [29].

Several studies have developed instructional materials for mathematics using Wordwall, spanning from elementary to high school levels. While these materials have undergone valid and practical testing, not all products have been tested for effectiveness. Only a limited number of studies have investigated the effectiveness of using Wordwall in mathematics education, and these studies have been limited to elementary [30], [31], [32] and junior high school [27] levels.

Regarding senior high school levels, the efficacy of Wordwall instructional materials tends to measure affective abilities, such as motivation and interest [33], as well as interactions among students [34]. No research has yet explored the effectiveness of Wordwall in enhancing mathematics learning outcomes at the senior high school or Phase E level. Thus, this gap in the literature serves as the basis for conducting the present study.

The current investigation addresses the following two research inquiries: 1) Is there an influence on the mathematics learning outcomes of Phase E students after utilizing the Wordwall game for instruction? 2) What is the effectiveness of implementing the Wordwall game in improving the mathematics learning achievements among Phase E students in mathematics instruction?

2. METHOD

Quantitative approaches with a quasi-experimental design, as delineated in Table 1, are utilized in the methodology of this study [35]. The research was conducted from September 29, 2023, to November 10, 2023, at SMAN 4 Pekanbaru, Riau Province, Indonesia. All 11 classes of tenth-grade students at SMAN 4 Pekanbaru constituted the population for this study. The sample was randomly selected in groups to obtain two representative classes. This selection was facilitated using Wordwall to ensure the presence of the Wordwall usage atmosphere earlier.

Table 1. Pre- and Posttest Design

Select Control Group	Pretest	No Treatment	Posttest
Select Experimental Group	Pretest	Wordwall Treatment	Posttest

The data collection instrument utilized in this research is specifically designed to evaluate the mathematics learning outcomes of students through the implementation of the Wordwall mathematical game. The Wordwall instructional tool used pertains to topics such as exponential functions and system of linear equations with two variables, which have been validated and proven practical [36]. The data collection instruments employed consist of pretest and posttest questions. The Pretest questions were administered to assess students' mathematics learning outcomes before any treatment was applied to both classes, while the posttest questions were utilized to evaluate their outcomes after undergoing distinct treatments.

A testing technique was employed as the data collection method in this study. This technique was utilized to obtain data regarding the students' initial abilities before any treatment, which would be acquired through pretest sheets conducted at the beginning of the session, and after the treatment, which would be obtained through posttest sheets conducted at the end of the session.

The test results obtained were analyzed using both descriptive and inferential analyses. In the descriptive data analysis, the researcher examined the mean, standard deviation, as well as the minimum and maximum scores of students' mathematics learning outcomes. In inferential data analysis, the researcher observed the differences in students' learning outcomes using the assistance of SPSS v.25.

In addition to statistical tests, this study also employed a data analysis technique to find out the effectiveness of implementing the Wordwall Game on students' mathematics learning outcomes when compared to conventional learning. This assessment will be measured using a metric known as Effect Size. The formula and criteria for Effect Size (ES) used are as follows [37]:

$$ES = \frac{Mean\ of\ experimental\ group - mean\ of\ control\ group}{pooled\ standard\ deviation}$$

To calculate the pooled deviation, the formula should be:

$$SD_{pooled} = \sqrt{\frac{(N_E - 1){SD_E}^2 + (N_C - 1){SD_C}^2}{N_E + N_C - 2}}$$

Where N_E = number in the experimental group, N_C = number in the control group, SD_E = standard deviation of the experimental group, and SD_C = standard deviation of the control group. The results of the effect size (ES) calculation are interpreted as shown in Table 2.

Table 2. Criteria of Effect Size

Criteria	Interpretation
$ES \leq 0{,}20$	Weak Effect
$0{,}20 < ES \leq 0{,}50$	Modest Effect
$0{,}50 < ES \leq 1{,}00$	Moderate Effect
$ES > 1{,}00$	Strong Effect

3. RESULTS AND DISCUSSION

3.1. Descriptive Statistical Analysis

The pretest and posttest data collected are analyzed descriptively to calculate the average, standard deviation, lowest value, and highest value. A summary of the results of the descriptive analysis of pretest and posttest data for Phase E students is presented in Table 3.

Table 3. Description of Pre- and Posttest Data of Students' Mathematics Learning Outcomes

Descriptive Statistics	Pretest		Posttest	
	Experimental Group	Control Group	Experimental Group	Control Group
N	38	37	38	37
$\bar{X}$	27,01	28,13	98,37	93,43
SD	17,81	12,82	7,76	9,55
Min	0	0	52	48
Max	63	41	100	100

According to the data presented in Table 3, it is evident descriptively that the mean mathematics learning achievements of students in both classes before the use of Wordwall in one class tend to be similar, with better data spread in the control class. The data in the experimental class (17,81) have a wider spread compared to the data in the control class (12,82). This difference arises because both classes have the same minimum value, but students who achieved the highest score were in the experimental class (63) with a significant difference of 22 points compared to the highest score in the control class.

After implementing Wordwall, there is a descriptive superiority in the mean mathematics learning achievement of students in the experimental class (98.37) compared to the control class, with an approximate 5-point difference in the average scores favoring the experimental group. The experimental class demonstrates a narrower data spread compared to the control class, as indicated by the smaller range observed in the experimental class (48) in contrast to the range observed in the control class (52).

In essence, initially, both classes seemed to have the same quality. However, after the implementation of Wordwall in the experimental class, the learning outcome improved.

3.2. Inferential Statistical Analysis

Subsequently, to investigate the research inquiries, inferential statistical methods were applied to analyze the data. However, before conducting these statistical tests, assumption tests were performed, namely tests for normality and homogeneity of variance. The test of normality was conducted as a requirement for analysis of variance, while the variance homogeneity test was performed as a requirement for the t-test. If the data did not follow a normal distribution, a nonparametric test, specifically the Mann-Whitney test, would be employed without going through the homogeneity test series.

The findings of the normality assessment for the pretest data of students in both instructional cohorts are depicted in Table 4.

Table 4. Normality Test of Pretest Data on Students' Mathematics Learning Outcomes

Shapiro-Wilk	Experimental Class	Control Class
Stat.	0,945	0,778
Df	38	37
Sig.	0,060	0,000

H_0: The sample is selected from a population exhibiting a normal distribution pattern.
H_1: The sample is selected from a population that is not exhibiting a normal distribution

The criterion used for testing is that if the p-value (Sig.) exceeds the predetermined significance level ($\propto = 0.05$), then H_0 is accepted; otherwise, H_0 is rejected. The normality test employed is the Shapiro-Wilk test, as the data size exceeds 30. In the table, it is evident that the probability value (sig.) for one of the datasets is below 0.05. This implies that H_0 is rejected, leading to the conclusion that the data for both groups do not follow a normal distribution. Consequently, the equivalence test for pretest data on student's mathematics learning achievements employs a non-parametric test, specifically the Mann-Whitney test, the outcomes of which are detailed in Table 5.

Table 5. Test of Equality of Pretest Data of Student's Mathematics Learning Outcome

Mann-Whitney	Z	Sig. (2-tailed)	H_0
612,000	-0,965	0,335	Accepted

$H_0: \mu_1 = \mu_2$
$H_1: \mu_1 \neq \mu_2$
where: μ_1 = average pretest data for mathematics learning achievement of students using Wordwall and μ_2 = average pretest data for mathematics learning achievement of students not using Wordwall.

The testing criterion utilized is that if the p-value (Sig.) exceeds the threshold of 0.05, then H_0 is accepted; otherwise, H_0 is rejected. In the table, it is noted that the probability value (sig.) exceeds 0.05, thus H_0 is accepted. Consequently, there exists no disparity between the pretest data concerning mathematics learning achievements within the experimental class and the control class.

Table 6. Normality Test of Posttest Data on Students' Mathematics Learning Outcomes

Shapiro-Wilk	Eksperimen	Kontrol
Stat.	0,203	0,614
Df	38	37
Sig.	0,000	0,000

H_0: The sample is selected from a population exhibiting a normal distribution pattern.
H_1: The sample is selected from a population that is not exhibiting a normal distribution.

Based on Table 6, it is evident that the probability value (sig.) for one of the datasets is below 0.05. Therefore, H_0 is rejected, indicating that the data for these two groups are not normally distributed. Consequently, the comparison of posttest data concerning students' mathematics learning achievements utilizes the Mann-Whitney test. The result is presented in Table 7.

Table 7. Test of Equality of Posttest Data of Students' Mathematics Learning Outcome

Mann-Whitney	Z	Sig. (2-tailed)	H_0
210,000	-5,480	0,000	Rejected

$H_0: \mu_1 = \mu_2$
$H_1: \mu_1 \neq \mu_2$

where: μ_1 = average posttest data for mathematics learning achievement of students using Wordwall and μ_2 = average posttest data for mathematics learning achievement of students not using Wordwall.

According to the table, the probability value (sig.) being below 0.05 leads to rejecting the null hypothesis (H_0), suggesting a significant difference between the posttest data on mathematics learning outcomes in the experimental class and the control class. Moreover, based on descriptive data, the experimental class demonstrates superior mathematics learning outcomes compared to the control class.

3.3. Effectiveness

In order to assess the efficacy of employing Wordwall on the mathematics learning outcomes of Phase E students, the computation of the effect size is conducted, as outlined in Table 8.

Table 8. Effect Size of Students' Mathematics Learning Outcomes

N_E	38
N_C	37
SD_E	7,76
SD_C	9,55
SD_{pooled}	8,69
$\bar{x}_E$	98,37
$\bar{x}_C$	93,43
ES	0,57

Based on the calculation results, the effectiveness of learning outcomes falls within the moderate criteria (0,57). The difference between this score and the strong category is quite significant. This is due to the minimal disparity between the average and data spread of the two classes.

In the implementation of Wordwall usage in the classroom, grouping is carried out due to the prohibition of mobile phone use in Indonesian schools [38], [39]. Students are only permitted to use laptops, although not all students have access to these devices. Consequently, the formation of groups becomes an alternative to ensure that all students can use Wordwall collectively. However, challenges arise when there is uneven participation among students within the groups. Only a portion of students actively completes Wordwall tasks. Furthermore, some students who could easily solve exercises in the textbook face confusion when using Wordwall. Students are not yet familiar with the presentation style [40], [41]. This indicates that students within each group exhibit diverse characteristics [42] and learning styles [43], [44], underscoring the importance of considering learning styles before the initiation of interventions.

Moreover, it is advisable that Wordwall is designed not solely as an exercise tool but as a knowledge transformation instrument. The use of technology throughout the learning activities is believed to be more effective than its partial application. This strategy can enhance the effectiveness of Wordwall as an integral component of the educational process.

4. CONCLUSION

In conclusion, this study demonstrated a statistically significant difference (sig. 0.000 < 0.05) in the mean academic achievement of students who learned using Wordwall compared to those who did not. Descriptively, the experimental group exhibited higher average mathematics learning outcomes compared to the control group, with a moderate level of effectiveness (ES = 0.57). The heightened effectiveness of Wordwall can be achieved by utilizing it not only as a classroom exercise tool but also as a medium for knowledge transformation, taking into account the diverse learning styles of students.

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REFERENCES (10 PT)

[1] J. Engelbrecht, S. Llinares, and M. C. Borba, "Transformation of the mathematics classroom with the internet," *ZDM*, vol. 52, no. 5, pp. 825–841, Oct. 2020, doi: 10.1007/s11858-020-01176-4.

[2] Karcher, E. L., Wardwell,B., Ragland, E., York, A., Machaty, Z., Stewart, K.,Radcliffe, S., & Lott, E. A. (2023). Adapting theprogram redesign model for a student-centeredcurricula renewal in animal science.Natural SciencesEducation,52,e20105.https://doi.org/10.1002/nse2.20105

[3] Falbe, K.N.; Seglem, R. Teaching Is Messy: Using Lesson Study to Reimagine Student-Centered Clinical Experiences. Educ. Sci. 2023, 13, 735. https://doi.org/10.3390/educsci13070735

[4] Tuval Avishai, Alik Palatnik. How teachers' knowledge and didactic contract evolve when transitioning to student-centered pedagogy - the case of project-based learning. Twelfth Congress of the European Society for Research in Mathematics Education (CERME12), Feb 2022, Bozen-Bolzano, Italy. hal-03748713.

[5] Iddrisu Bariham, Evelyn Kuusozume Yirbekyaa, & Anthony Bordoh. (2022). Teachers Perspective on Redesigning Social Studies Curriculum for Student-Centered and Constructivist Learning: Empirical Study of Secondary Schools, Northern Region. Social Education Research, 3(2), 307–321. https://doi.org/10.37256/ser.3220221676

[6] M. Lafuente-Lechuga, J. Cifuentes-Faura, and Ú. Faura-Martínez, "Mathematics Applied to the Economy and Sustainable Development Goals: A Necessary Relationship of Dependence," *Educ Sci (Basel)*, vol. 10, no. 11, p. 339, Nov. 2020, doi: 10.3390/educsci10110339.

[7] AlAli, R.; Alsoud, K.; Athamneh, F. Towards a Sustainable Future: Evaluating the Ability of STEM-Based Teaching in Achieving Sustainable Development Goals in Learning. Sustainability 2023, 15, 12542. https://doi.org/10.3390/su151612542

[8] J. Samuelsson, "Developing students' relationships with mathematics," *Educ Action Res*, vol. 31, no. 2, pp. 180–194, Mar. 2023, doi: 10.1080/09650792.2021.1899012.

[9] Polman, J., Horustra, L. & Volman, M. The meaning of meaningful learning in mathematics in upper-primary education. Learning Environ Res 24, 469–486 (2021). https://doi.org/10.1007/s10984-020-09337-8

[10] F. Wang *et al.*, "Neural Cognitive Diagnosis for Intelligent Education Systems," *Proceedings of the AAAI Conference on Artificial Intelligence*, vol. 34, no. 04, pp. 6153–6161, Apr. 2020, doi: 10.1609/aaai.v34i04.6080.

[11] Camacho, A., Alves, R.A. & Boscolo, P. Writing Motivation in School: a Systematic Review of Empirical Research in the Early Twenty-First Century. Educ Psychol Rev 33, 213–247 (2021). https://doi.org/10.1007/s10648-020-09530-4

[12] Rafiola, R., Setyosari, P., Radjah, C. & Ramli, M. (2020). The Effect of Learning Motivation, Self-Efficacy, and Blended Learning on Students' Achievement in The Industrial Revolution 4.0. International Journal of Emerging Technologies in Learning (iJET), 15(8), 71-82. Kassel, Germany: International Journal of Emerging Technology in Learning. Retrieved February 1, 2024 from https://www.learntechlib.org/p/217073/.

[13] Coutinho, S.A., Neuman, G. A model of metacognition, achievement goal orientation, learning style and self-efficacy. Learning Environ Res 11, 131–151 (2008). https://doi.org/10.1007/s10984-008-9042-7

[14] Amal Alhadabi & Aryn C. Karpinski (2020) Grit, self-efficacy, achievement orientation goals, and academic performance in University students, International Journal of Adolescence and Youth, 25:1, 519-535, DOI: 10.1080/02673843.2019.1679202

[15] Hongbin Wu, Shan Li, Juan Zheng & Jianru Guo (2020) Medical students' motivation and academic performance: the mediating roles of self-efficacy and learning engagement, Medical Education Online, 25:1, DOI: 10.1080/10872981.2020.1742964

[16] Schunk, D.H., Mullen, C.A. (2012). Self-Efficacy as an Engaged Learner. In: Christenson, S., Reschly, A., Wylie, C. (eds) Handbook of Research on Student Engagement. Springer, Boston, MA. https://doi.org/10.1007/978-1-4614-2018-7_10

[17] S. Huang and N. Fang, "Predicting student academic performance in an engineering dynamics course: A comparison of four types of predictive mathematical models," *Comput Educ*, vol. 61, pp. 133–145, Feb. 2013, doi: 10.1016/j.compedu.2012.08.015.

[18] Toni Honicke, Jaclyn Broadbent & Matthew Fuller-Tyszkiewicz (2020) Learner self-efficacy, goal orientation, and academic achievement: exploring mediating and moderating relationships, Higher Education Research & Development, 39:4, 689-703, DOI: 10.1080/07294360.2019.1685941

[19] R. Raj *et al.*, "Professional Competencies in Computing Education," in *Proceedings of the 2021 Working Group Reports on Innovation and Technology in Computer Science Education*, New York, NY, USA: ACM, Dec. 2021, pp. 133–161. doi: 10.1145/3502870.3506570.

[20] G. P. TÜRKMEN and D. SOYBAŞ, "The Effect Of Gamification Method On Students' Achievements and Attitudes Towards Mathematics," *Bartın Üniversitesi Eğitim Fakültesi Dergisi*, vol. 8, no. 1, pp. 258–298, Feb. 2019, doi: 10.14686/buefad.424575.

[21] A. Manzano-León *et al.*, "Between Level Up and Game Over: A Systematic Literature Review of Gamification in Education," *Sustainability*, vol. 13, no. 4, p. 2247, Feb. 2021, doi: 10.3390/su13042247.

[22] E. Ceker and F. Ozdamli, "What 'Gamification' is and what it's not," *European Journal of Contemporary Education*, vol. 6, no. 2, pp. 221–228, Jun. 2017, doi: 10.13187/ejced.2017.2.221.

[23] L. M. Carmona-Chica and A. L. Argudo-Garzón, "Vocabulary skills and virtual tools in students of A2 Universidad Católica de Cuenca," *Revista Arbitrada Interdisciplinaria Koinonía*, vol. 7, no. 1, p. 23, Jun. 2022, doi: 10.35381/r.k.v7i1.1677.

[24] Chandra Segaran, V., & Hashim, H. (2022). 'More Online Quizzes, Please!' The Effectiveness of Online Quiz Tools in Enhancing the Learning of Grammar among ESL Learners. International Journal of Academic Research in Business and Social Sciences.

[25] A. Bilova, "IMPLEMENTING ENJOYABLE LEARNING STRATEGY WITH WORDWALL IN THE EFL CLASSROOM", Anglistics and Americanistics, no. 20, pp. 58-64, Jun. 2023.

[26] Chans GM, Portuguez Castro M. Gamification as a Strategy to Increase Motivation and Engagement in Higher Education Chemistry Students. Computers. 2021; 10(10):132. https://doi.org/10.3390/computers10100132

[27] T. K. Rahma *et al.*, "Using wordwall as a gamification-based mathematics learning material to support students' learning activities," 2023, p. 020043. doi: 10.1063/5.0141610.

[28] Kurniawan, H, Supriyono, Tursilowati, & Kustiningsih, I. J. (2021). Action Research: CPA Math Word Wall Group Competition to Improve Conceptual Understanding in Algebra Problem Solving Activities. 2nd International Conference on Education and Technology (ICETECH 2021): Advances in Social Science, Education and Humanities Research. Atlantis Press.

[29] C. Rodrigues-Escobar, J. Cuevas-Lepe, and L. Maluenda-Parragues, "Assessing the Effectiveness of Wordwall.net as a Vocabulary Learning Tool: Pre-Service EFL Teachers' Perspectives," *Journal of Education and Practice*, vol. 14, no. 31, 2023.

[30] M. Pahoura and C. Dimoulas, "Digital Storytelling in Education: A Transmedia Integration Approach for the Non-Developers," *Educ Sci (Basel)*, vol. 12, no. 8, p. 559, Aug. 2022, doi: 10.3390/educsci12080559.

[31] C. S. Hibaya, T. Pasawano, and T. Sottiwan, *Development of Online Lesson to Enhance Mathematics Achievement for Grade 3 Students*, vol. 4. Thailand: King Mongkut's Instituteof Technology Ladkrabang Princeof Chumphon Campus, 2023.

[32] S. Sudarsono and Sapriya, "Development Of Web-Based Interactive Game Media Application Wordwall Material Odd Numbers Even Mathematics Subjects Grade Ii Elementary School," *Proceeding The 5th International Conference On Elementary Education*, vol. 5, no. 1, pp. 629–639, 2023.

[33] E. Shafwa and A. Hikmat, "The Effectiveness of Evaluation of Mathematics Learning Using Wordwall Media in Elementary School," *Scaffolding: Jurnal Pendidikan Islam dan Multikulturalisme*, vol. 5, no. 3, pp. 1–12, Aug. 2023, doi: 10.37680/scaffolding.v5i2.3406.

[34] K. I. Lestari, I. N. Arcana, A. E. Susetyo, and K. S. Kuncoro, "Development of Online Learning Quiz and Educational Game Using Word Walls in Mathematics for Grade 10," *INSANIA : Jurnal Pemikiran Alternatif Kependidikan*, vol. 27, no. 2, pp. 145–159, Dec. 2022, doi: 10.24090/insania.v27i2.6924.
[35] M. Bueno, F. Perez, R. Valerio, and E. M. Q. Areola, "A Usability Study on Google Site and Wordwall.net: Online Instructional Tools for Learning Basic Integration Amid Pandemic," *Journal of Global Business and Social Entrepreneurship (GBSE)*, vol. 7, no. 23, pp. 61–71, 2022.
[36] John W. Creswell, *Educational research : planning, conducting, and evaluating quantitative and qualitative research*, 4th ed. Boston: Pearson, 2012.
[37] S. Rezeki, A. Dahlia, and S. Amelia, "PENGEMBANGAN MEDIA PEMBELAJARAN MATEMATIKA MENGGUNAKAN APLIKASI WORDWALL UNTUK PESERTA DIDIK FASE E," *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, vol. 12, no. 3, p. 3136, Sep. 2023, doi: 10.24127/ajpm.v12i3.7188.
[38] Cohen L., L. Manion, and K. Morrison, *Research Methods in Education*. New York: Routledge, 2017.
[39] N. Alia and N. Siagian, "PENGGUNAAN TEKNOLOGI INFORMASI DAN KOMUNIKASI DI MADRASAH ALIYAH NEGERI 1 SUKABUMI," *Penamas*, vol. 33, no. 1, p. 57, Aug. 2020, doi: 10.31330/penamas.v33i1.378.
[40] Zaenal Abidin, Anuradha Mathrani, Roberta Hunter & David Parsons (2017) Challenges of Integrating Mobile Technology into Mathematics Instruction in Secondary Schools: An Indonesian Context, Computers in the Schools, 34:3, 207-222, DOI: 10.1080/07380569.2017.1344056
[41] S. Asgari, J. Trajkovic, M. Rahmani, W. Zhang, R. C. Lo, and A. Sciortino, "An observational study of engineering online education during the COVID-19 pandemic," *PLoS One*, vol. 16, no. 4, p. e0250041, Apr. 2021, doi: 10.1371/journal.pone.0250041.
[42] A. Selvaraj, V. Radhin, N. KA, N. Benson, and A. J. Mathew, "Effect of pandemic based online education on teaching and learning system," *Int J Educ Dev*, vol. 85, p. 102444, Sep. 2021, doi: 10.1016/j.ijedudev.2021.102444.
[43] S. Zhang, Y. Wen, and Q. Liu, "Exploring student teachers' social knowledge construction behaviors and collective agency in an online collaborative learning environment," *Interactive Learning Environments*, vol. 30, no. 3, pp. 539–551, Feb. 2022, doi: 10.1080/10494820.2019.1674880.
[44] F. Rasheed and A. Wahid, "Learning style detection in E-learning systems using machine learning techniques," *Expert Syst Appl*, vol. 174, p. 114774, Jul. 2021, doi: 10.1016/j.eswa.2021.114774.
[45] Muhammad Awais Hassan, Ume Habiba, Fiaz Majeed & Muhammad Shoaib (2021) Adaptive gamification in e-learning based on students' learning styles, Interactive Learning Environments, 29:4, 545-565, DOI: 10.1080/10494820.2019.1588745

BIOGRAPHIES OF AUTHORS

Sri Rezeki is a Senior Lecturer in the Mathematics Education Department at FKIP UIR, specializing in educational media, learning resources, and statistics. Born in Tanjung Uban on January 15, 1971, Sri pursued her higher education in Mathematics Education at Universitas Riau (Bachelor's), Statistics at Institut Pertanian Bogor (Master's), and Mathematics at Universitas Gajah Mada (Doctoral). With a rich academic background and expertise in her field, Sri can be reached via email at sri_rezeki@edu.uir.ac.id.

Sindi Amelia is a lecturer of Mathematics Education Department at FKIP UIR, specializing in Curriculum and Instruction, Educational Media and Resources, Analysis, and Geometry. Born in Kerinci on November 25, 1988, Sindi pursued her higher education in Mathematics Education at Universitas Riau (Bachelor's) and Universitas Pendidikan Indonesia (Master's). With a passion for teaching and expertise in various aspects of mathematics education, Sindi can be contacted via email at sindiamelia88@edu.uir.ac.id.

2. Bukti konfirmasi permintaan revisi yang kedua dan submit revisi yang kedua (28 Februari 2024)

UIRmail

sindi amelia <sindiamelia88@edu.uir.ac.id>

[IJERE] Editor Decision - Revisions Required

3 messages

Dr. Lina Handayani <ijere@iaescore.com> Wed, Feb 28, 2024 at 4:43 PM
Reply-To: "Dr. Lina Handayani" <linafkm@gmail.com>
To: Sindi Amelia <sindiamelia88@edu.uir.ac.id>
Cc: Sri Rezeki <sri_rezeki@edu.uir.ac.id>

The following message is being delivered on behalf of International Journal of Evaluation and Research in Education (IJERE).

-- Paper ID#

Dear Prof/Dr/Mr/Mrs. Sindi Amelia,

We have reached a decision regarding your submission entitled "Enhancing Mathematics Learning in Phase E: Evaluating the Effectiveness of the Wordwall Game" to International Journal of Evaluation and Research in Education (IJERE), p-ISSN: 2252-8822, e-ISSN: 2620-5440, a Scopus (https://www.scopus.com/sourceid/21100934092) and Scimagojr (https://www.scimagojr.com/journalsearch.php?q=21100934092&tip=sid&clean=0) indexed journal.

Our decision is that major revisions required.
Please read the checklist for preparing your paper for publication at: https://ijere.iaescore.com/index.php/IJERE/about/editorialPolicies#custom-2.
Please try to adhere to the format as closely as possible.
Authors should have made substantial/intellectual contribution (the new findings with contrast to the existing works). Highlight the main theme of the work with the specific goals of the design and development approach.

Please submit your revised paper in MS Word file format, and submit revised paper within 8 weeks through our online system at same ID number (NOT as new submission) on Tab "Review" as "Author Version" file. Then, your revised paper will be judged for final decision of acceptance or rejection.

I look forward for hearing from you

Thank you

Best Regards,
Dr. Lina Handayani
Universitas Ahmad Dahlan
Phone +62274379418
Fax +62274381523
linafkm@gmail.com

The following is an example of a template for responding to reviewers:

I would like to thank the reviewers for their insightful feedback. All comments from Reviewer 1 are highlighted in yellow, those from Reviewer 2 are highlighted in red, and those from Reviewer 3 are highlighted in green.

- Reviewer #1 -

Comment 1: There are some references that are not required.
Response: We thoroughly updated our references; 5 references were eliminated, and two were replaced by more recent publications.

Comment 2: The presentation of Figures 2 and 3 should be improved.
Response: The necessary adjustments have been made.

Comment 3: Equation (2) seems to be incorrect.
Response: Equation (2) is correct. This can be proven as follows:...
In order to clarify equation 9 in the manuscript, the following remarks have been added... etc.

All changes for reviewer 1 are highlighted in yellow in the main text.

- Reviewer #2 -

Comment 1:
Response:

Comment 2:
Response:

Comment 3:
Response:

All changes for reviewer 2 are highlighted in red in the main text.

Etc.

Such a document clarifies everything and will aid the reviewers in evaluating the work fast.
When providing your amended primary document files, you must also upload your corrections statement. Before your manuscript, the declaration of revisions should appear.

Reviewer B:

The IJERE form to evaluate submitted papers
Content:
Very good

Significance:
Fair

Originality:
Excellent

Relevance:
Excellent

Presentation:
Good

Recommendation:
Very good

Comments to the Author

This comment will be visible to the Author
:
There is still a lot of room for development that can be achieved for continued research, especially by changing several variables in the selection of topics studied and also the media used

---

Reviewer F:

The IJERE form to evaluate submitted papers

Content:
Good

Significance:
Fair

Originality:
Fair

Relevance:
Fair

Presentation:
Fair

Recommendation:
Fair

Comments to the Author

This comment will be visible to the Author
:
- In the keywords add there are a minimum of 5 and a maximum of 7 words and must not contain abbreviations and sort the words according to alphabetized (A-Z).
- Check each paragraph in the body of the text, make sure no paragraph is less than 3 sentences, if less, add or combine with the previous/next paragraph.
- In the bodytext check each paragraph for the use of periods and commas if it is a number. Periods for decimals, commas for thousands.
- Check and adjust each equation writing with the one in the template.
- Cite and provide explanations for tables (1-8) before the table is presented.
- Check each tables for the use of periods and commas if it is a number. Periods for decimals, commas for thousands.
- Customize the writing of each tables on your paper with the template (font, lines, paragraphs, top and bottom spacing and more as detailed as possible).
- The DISCUSSION section must be supported by at least 10 references and each paragraph has at least one reference.
- Complete the title and the first author's name in the Header and Footer.
- In the reference section use IEEE + DOI style writing 8pt (https://ieeeauthorcenter.ieee.org/wp-content/uploads/IEEE-Reference-Guide.pdf)
- Delete/replace references number 20 and 22 that use local language with citations from reputable international journals.
- References from journal articles should be completed with vol., issue, page, year, DOI (check for existing References).
- In the biography section, include links to the researcher's social media accounts as complete and true as possible to make it easier for readers to find author information: Scopus, ORCID (required), Google Scholar, Web of Science/WoS (if applicable).

**It is important that you follow as much detail as possible the template writing (font, spacing, paragraphs, styles and other things)
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International Journal of Evaluation and Research in Education (IJERE)
http://ijere.iaescore.com

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sindi amelia <sindiamelia88@edu.uir.ac.id> Wed, Feb 28, 2024 at 8:24 PM
To: Sri Rezeki <sri_rezeki@edu.uir.ac.id>

[Quoted text hidden]
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Sindi Amelia
Lecturer in Mathematics Education Study Program

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sindi amelia <sindiamelia88@edu.uir.ac.id> Thu, Feb 29, 2024 at 6:02 AM
To: "Dr. Lina Handayani" <linafkm@gmail.com>

Dear Editor,

Thank you for the information. Could you please provide me with the reviewed file? I've checked the OJS, but it hasn't been uploaded yet.

Thank you.

[Quoted text hidden]
[Quoted text hidden]

UIRmail

sindi amelia <sindiamelia88@edu.uir.ac.id>

[IJERE] Editor Decision - Revisions Required

2 messages

Dr. Lina Handayani <ijere@iaescore.com> Sat, Mar 16, 2024 at 5:30 PM
Reply-To: "Dr. Lina Handayani" <linafkm@gmail.com>
To: Sindi Amelia <sindiamelia88@edu.uir.ac.id>
Cc: Sri Rezeki <sri_rezeki@edu.uir.ac.id>

The following message is being delivered on behalf of International Journal of Evaluation and Research in Education (IJERE).

-- Paper ID#

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Our decision is that major revisions required.
Please read the checklist for preparing your paper for publication at:
https://ijere.iaescore.com/index.php/IJERE/about/editorialPolicies#custom-2.
Please try to adhere to the format as closely as possible.
Authors should have made substantial/intellectual contribution (the new findings with contrast to the existing works). Highlight the main theme of the work with the specific goals of the design and development approach.

Please submit your revised paper in MS Word file format, and submit revised paper within 8 weeks through our online system at same ID number (NOT as new submission) on Tab "Review" as "Author Version" file. Then, your revised paper will be judged for final decision of acceptance or rejection.

I look forward for hearing from you

Thank you

Best Regards,
Dr. Lina Handayani
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Reviewer A:

Please answer the following questions!
- Why did you do the study?
- Why is the study relevant?
- What did you do?
- What approach did you use?
- What did you find?
- What did you conclude?

Reorganize your abstract by stating the problem clearly, proposing a

solution or approach, and emphasizing key findings and conclusions within 150-200 words.

Writing a discussion can be a delicate balance between summarizing your results, providing proper context for your research and avoiding introducing new information. Remember that your paper should be both confident and honest about the results!

What are the implications of your findings? What will be helpful in the future?

Reviewer B:

Please provide responses and explanations for the following questions.
1. What is the scientific question you are addressing?
2. What is the key finding that answers this question?
3. What is the nature of the evidence you provide in support of your conclusion?
4. What significance do your results have for the field and the broader community?
5. Is there additional information that we should take into account?

This paper contains no critical discussion or interpretation.
What are the ramifications of your findings? What will come in handy in the future?

-

Reviewer A:

The IJERE form to evaluate submitted papers
Content:
Good

Significance:
Fair

Originality:
Fair

Relevance:
Good

Presentation:
Very good

Recommendation:
Good

Comments to the Author

This comment will be visible to the Author
:
The objectives and tools used are correct, but it can be more detailed regarding several things related to what media is used and how to use it, if this is done it will be easier to develop other research.

Reviewer B:

The IJERE form to evaluate submitted papers
Content:
Good

Significance:
Good

Originality:
Fair

Relevance:
Good

Presentation:
Good

Recommendation:
Fair

Comments to the Author

This comment will be visible to the Author
:
**The manuscript "Enhancing Mathematics Learning in Phase E: Assessing Wordwall Effectiveness" is good and has undergone revision changes, but there are still some things that need to be improved to make it better than before, especially on the appearance.
Please follow the improvement suggestions below:

- In the body of the text check the paragraphs in each section and make sure no paragraph is less than 3 sentences, if it is less, combine it with the paragraph after/previous to it or add a sentence.
(1. INTRODUCTION, 2. METHOD, 3. RESULTS AND DISCUSSION)
- In the bodytext check each paragraph for the use of periods and commas if it is a number. Periods for decimals, commas for thousands.
(Section 3. RESULTS AND DISCUSSION)
- Cite and provide explanations for each tables before it is presented.
(Table 6)
- Check each tables for the use of periods and commas if it is a number. Periods for decimals, commas for thousands.
(Table 2-8)
- Insert reference number [45] into the citations sequentially in the body of the text.
- References from journal articles should be completed with vol., issue, page, year, DOI.
(References number [25], [29], and [35])
- Remove/change local references by citing from reputable international journals.
(Reference numbers [37] and [39])

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sindi amelia <sindiamelia88@edu.uir.ac.id> Tue, Jul 23, 2024 at 9:45 AM
To: "Dr. Lina Handayani" <linafkm@gmail.com>

Dear Editor-in-Chief,

I hope this letter finds you well. I am writing to inquire about the status of my manuscript, titled "Enhancing Mathematics Learning in Phase E: Evaluating the Effectiveness of the Wordwall Game," which was submitted to International Journal of Evaluation and Research ini Education (IJERE) on 2024-01-27 (Manuscript ID: 30051).

On 2024-04-15, I submitted a revised version of my manuscript in response to the reviewers' comments. Since then, almost four months have passed, and I have not received any updates regarding the progress of my submission.

Understanding the review process can be time-consuming, I am concerned about the prolonged silence and would appreciate any information you could provide regarding the current status of my manuscript. Specifically, I would like to know if there have been any further developments or if additional information is required from my end to facilitate the process.

I believe that the findings presented in my manuscript are of significant interest to the readers of IJERE, and I am eager to see it published. Hence, any updates or insights you can provide would be highly valuable.

Thank you for your attention to this matter. I look forward to your response and appreciate your assistance in expediting the review process.

Sincerely,

[Quoted text hidden]

--
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International Journal of Evaluation and Research in Education (IJERE)
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ISSN: 2252-8822, DOI: 10.11591/ijere.v99i1.paperID

Enhancing Mathematics Learning in Phase E: Assessing Wordwall Effectiveness

Sri Rezeki[1], Sindi Amelia[1]
[1]Mathematics Education Department, Faculty of Teacher Training and Education, Universitas Islam Riau, Pekanbaru, Indonesia

Article Info

Article history:

Received mm dd, yyyy
Revised mm dd, yyyy
Accepted mm dd, yyyy

Keywords:

Effectiveness
Gamification
Mathematics Learning
Phase E
Wordwall

ABSTRACT

The use of technology, classroom atmosphere, facilities, and learning resources can support quality learning outcomes in students. Wordwall, as a gamification tool, has been proven to be effective for elementary and junior high school students in mathematics. However, the effectiveness of Wordwall in enhancing senior high school students' cognitive abilities in mathematics learning has not been investigated. Previous studies have only shown its effectiveness in improving affective abilities. Therefore, This study endeavors to evaluate the effects of using Wordwall on the mathematics learning outcomes of senior high school students in Phase E. Through quasi-experimental research with pre- and posttest group design, 38 experimental class students and 37 control class students were selected as samples in this study. The study found a statistically significant difference (sig. 0.000<0.05) in the mean learning outcomes of students who used Wordwall compared to those who did not. Descriptively, The experimental group displayed superior average mathematics learning outcomes compared to the control group, demonstrating a moderate level of effectiveness (ES=0.57). The strong effect of Wordwall can be realized if it is used not only as an exercise tool within the classroom but also as an instrument for knowledge transformation, incorporating consideration of students' learning styles.

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1. INTRODUCTION

Science and technology discipline is currently advancing rapidly, influencing various aspects of human life, including education. Since the 1970s, technology has transformed mathematics education and will undoubtedly play a major role in shaping the future of education compared to today. Educators realize the necessity to reconsider the entire education model and redesign it to be more student-centered [1], [2], [3], [4], [5].

Mathematics profoundly influences the attainment of the Sustainable Development Goals (SDGs). Simultaneously, these goals facilitate the exploration of real-life situations within the realm of mathematics, fostering active learning for students [6], [7]. In this context, each learning objective in a mathematics lesson is linked to something meaningful for the students, incorporating aspects of their daily lives [8], [9]. Therefore, mathematics education can genuinely prepare human resources to compete in the global era.

The obtained information reveals that the teaching and learning process lacks integration with technology. Consequently, students experience demotivation due to feelings of monotony and boredom associated with book-based learning and the limited communicative role of teachers. Low motivation leads to

a decline in academic achievement [10], [11], [12]. To improve academic performance, students must consider Psychological aspects such as learning preferences, self-efficacy, and goals for achievement [13], motivation [14], [15], interests [16], and the teaching and learning environment [17], [18].

Academic performance fundamentally encompasses skills related to knowledge, skills, attitudes, and values manifested in habits of thinking and behaving. Experiencing understanding "in action" involves integrating content knowledge and cognitive competencies with the demonstration of perspective, empathy, and self-awareness—qualities collectively termed as professional dispositions [19]. A potential remedy to enhance engagement and motivation in students involves the adoption of gamification. Gamification represents an approach that incorporates game components outside the typical gaming environment [20], [21], [22].

Utilizing virtual gamification platforms like Wordwall.net holds the potential to heighten students' interest in their learning processes [23], [24], [25]. This approach is considered highly suitable for mathematics students, fostering engagement in various learning activities [26], [27]. Wordwall, functioning as an educational technology tool, is intentionally designed to facilitate interactive learning in diverse settings. It empowers both educators and learners to create personalized interactive materials, thereby enriching individual and collaborative learning experiences. These interactive resources are applicable in various pedagogical contexts, including formative assessment and gamified learning.

The Wordwall tool offers a wide array of templates, such as quizzes, matching exercises, word searches, and crossword puzzles, all of which can be customized to meet users' specific needs. Noteworthy characteristics also encompass its accessibility, adaptability, and the potential for collaboration between student and teacher teams [28]. Wordwall is accessible via any web-enabled device, encompassing interactive whiteboards, tablets, desktop and portable computers, or smartphones. Its simplicity makes it user-friendly, facilitating easy operation for average users [29].

Several studies have developed instructional materials for mathematics using Wordwall, spanning from elementary to high school levels. While these materials have undergone valid and practical testing, not all products have been tested for effectiveness. Only a limited number of studies have investigated the effectiveness of using Wordwall in mathematics education, and these studies have been limited to elementary [30], [31], [32] and junior high school [27] levels.

Regarding senior high school levels, the efficacy of Wordwall instructional materials tends to measure affective abilities, such as motivation and interest [33], as well as interactions among students [34]. No research has yet explored the effectiveness of Wordwall in enhancing mathematics learning outcomes at the senior high school or Phase E level. Thus, this gap in the literature serves as the basis for conducting the present study. The current investigation addresses the following two research inquiries: 1) Is there an influence on the mathematics learning outcomes of Phase E students after utilizing the Wordwall game for instruction? 2) What is the effectiveness of implementing the Wordwall game in improving the mathematics learning achievements among Phase E students in mathematics instruction?

2. METHOD

Quantitative approaches with a quasi-experimental design, as delineated in Table 1, are utilized in the methodology of this study [35]. The research was conducted from September 29, 2023, to November 10, 2023, at SMAN 4 Pekanbaru, Riau Province, Indonesia. All 11 classes of tenth-grade students at SMAN 4 Pekanbaru constituted the population for this study. The sample was randomly selected in groups to obtain two representative classes. This selection was facilitated using Wordwall to ensure the presence of the Wordwall usage atmosphere earlier.

Table 1. Pre- and Posttest Design

Select Control Group	Pretest	No Treatment	Posttest
Select Experimental Group	Pretest	Wordwall Treatment	Posttest

The data collection instrument utilized in this research is specifically designed to evaluate the mathematics learning outcomes of students through the implementation of the Wordwall mathematical game. The Wordwall instructional tool used pertains to topics such as exponential functions and system of linear equations with two variables, which have been validated and proven practical [36]. The data collection instruments employed consist of pretest and posttest questions. The Pretest questions were administered to assess students' mathematics learning outcomes before any treatment was applied to both classes, while the posttest questions were utilized to evaluate their outcomes after undergoing distinct treatments.

A testing technique was employed as the data collection method in this study. This technique was utilized to obtain data regarding the students' initial abilities before any treatment, which would be acquired

through pretest sheets conducted at the beginning of the session, and after the treatment, which would be obtained through posttest sheets conducted at the end of the session. The test results obtained were analyzed using both descriptive and inferential analyses. In the descriptive data analysis, the researcher examined the mean, standard deviation, as well as the minimum and maximum scores of students' mathematics learning outcomes. In inferential data analysis, the researcher observed the differences in students' learning outcomes using the assistance of SPSS v.25.

In addition to statistical tests, this study also employed a data analysis technique to find out the effectiveness of implementing the Wordwall Game on students' mathematics learning outcomes when compared to conventional learning. This assessment will be measured using a metric known as Effect Size. The formula and criteria for Effect Size (ES) used are as follows [37]:

$$ES = \frac{Mean\ of\ experimental\ group - mean\ of\ control\ group}{pooled\ standard\ deviation}$$

To calculate the pooled deviation, the formula should be:

$$SD_{pooled} = \sqrt{\frac{(N_E - 1){SD_E}^2 + (N_C - 1){SD_C}^2}{N_E + N_C - 2}}$$

Where N_E = number in the experimental group, N_C = number in the control group, SD_E = standard deviation of the experimental group, and SD_C = standard deviation of the control group. The results of the effect size (ES) calculation are interpreted as shown in Table 2.

Table 2. Criteria of Effect Size

Criteria	Interpretation
$ES \leq 0.20$	Weak Effect
$0.20 < ES \leq 0.50$	Modest Effect
$0.50 < ES \leq 1.00$	Moderate Effect
$ES > 1.00$	Strong Effect

3. RESULTS AND DISCUSSION

3.1. Descriptive Statistical Analysis

The pretest and posttest data collected are analyzed descriptively to calculate the average, standard deviation, lowest value, and highest value. These statistical measures provide a comprehensive understanding of the distribution and central tendencies within the dataset. A summary of the results of the descriptive analysis of pretest and posttest data for Phase E students is presented in Table 3.

Table 3. Description of Pre- and Posttest Data of Students' Mathematics Learning Outcomes

Descriptive Statistics	Pretest		Posttest	
	Experimental Group	Control Group	Experimental Group	Control Group
N	38	37	38	37
$\bar{X}$	27.01	28.13	98.37	93.43
SD	17.81	12.82	7.76	9.55
Min	0	0	52	48
Max	63	41	100	100

According to the data presented in Table 3, it is evident descriptively that the mean mathematics learning achievements of students in both classes before the use of Wordwall in one class tend to be similar, with better data spread in the control class. The data in the experimental class (17.81) have a wider spread compared to the data in the control class (12.82). This difference arises because both classes have the same minimum value, but students who achieved the highest score were in the experimental class (63) with a significant difference of 22 points compared to the highest score in the control class.

After implementing Wordwall, there is a descriptive superiority in the mean mathematics learning achievement of students in the experimental class (98.37) compared to the control class, with an approximate 5-point difference in the average scores favoring the experimental group. The experimental class demonstrates a narrower data spread compared to the control class, as indicated by the smaller range observed in the experimental class (48) in contrast to the range observed in the control class (52). In essence, initially, both classes seemed to have the same quality. However, after the implementation of Wordwall in the experimental class, the learning outcome improved.

3.2. Inferential Statistical Analysis

Subsequently, to investigate the research inquiries, inferential statistical methods were applied to analyze the data. However, before conducting these statistical tests, assumption tests were performed, namely tests for normality and homogeneity of variance. The test of normality was conducted as a requirement for analysis of variance, while the variance homogeneity test was performed as a requirement for the t-test. If the data did not follow a normal distribution, a nonparametric test, specifically the Mann-Whitney test, would be employed without going through the homogeneity test series. The findings of the normality assessment for the pretest data of students in both instructional cohorts are depicted in Table 4.

Table 4. Normality Test of Pretest Data on Students' Mathematics Learning Outcomes

Shapiro-Wilk	Experimental Class	Control Class
Stat.	0.945	0.778
Df	38	37
Sig.	0.060	0.000

H_0: The sample is selected from a population exhibiting a normal distribution pattern.
H_1: The sample is selected from a population that is not exhibiting a normal distribution

The criterion used for testing is that if the p-value (Sig.) exceeds the predetermined significance level ($\propto = 0.05$), then H_0 is accepted; otherwise, H_0 is rejected. The normality test employed is the Shapiro-Wilk test, as the data size exceeds 30. In the table, it is evident that the probability value (sig.) for one of the datasets is below 0.05. This implies that H_0 is rejected, leading to the conclusion that the data for both groups do not follow a normal distribution. Consequently, the equivalence test for pretest data on student's mathematics learning achievements employs a non-parametric test, specifically the Mann-Whitney test, the outcomes of which are detailed in Table 5.

Table 5. Test of Equality of Pretest Data of Student's Mathematics Learning Outcome

Mann-Whitney	Z	Sig. (2-tailed)	H_0
612.000	-0.965	0.335	Accepted

$H_0: \mu_1 = \mu_2$
$H_1: \mu_1 \neq \mu_2$
where: μ_1 = average pretest data for mathematics learning achievement of students using Wordwall and μ_2 = average pretest data for mathematics learning achievement of students not using Wordwall.

The testing criterion utilized is that if the p-value (Sig.) exceeds the threshold of 0.05, then H_0 is accepted; otherwise, H_0 is rejected. In the table, it is noted that the probability value (sig.) exceeds 0.05, thus H_0 is accepted. Consequently, there exists no disparity between the pretest data concerning mathematics learning achievements within the experimental class and the control class. After statistically confirming that both classes have the same average test scores, the next step is to analyze the post-test data to determine whether Wordwall has an effect on mathematics student learning outcomes. This analysis begins with a normality test, as depicted in Table 6.

Table 6. Normality Test of Posttest Data on Students' Mathematics Learning Outcomes

Shapiro-Wilk	Eksperimen	Kontrol
Stat.	0.203	0.614
Df	38	37
Sig.	0.000	0.000

H_0: The sample is selected from a population exhibiting a normal distribution pattern.
H_1: The sample is selected from a population that is not exhibiting a normal distribution.

Based on Table 6, it is evident that the probability value (sig.) for one of the datasets is below 0.05. Therefore, H_0 is rejected, indicating that the data for these two groups are not normally distributed. Consequently, the comparison of posttest data concerning students' mathematics learning achievements utilizes the Mann-Whitney test. The result is presented in Table 7.

Table 7. Test of Equality of Posttest Data of Students' Mathematics Learning Outcome

Mann-Whitney	Z	Sig. (2-tailed)	H_0
210.000	-5.480	0.000	Rejected

$H_0: \mu_1 = \mu_2$
$H_1: \mu_1 \neq \mu_2$

where: μ_1 = average posttest data for mathematics learning achievement of students using Wordwall and μ_2 = average posttest data for mathematics learning achievement of students not using Wordwall.

According to the data presented in the table, a probability value (sig.) being below 0.05 leads to rejecting the null hypothesis (H_0), suggesting a significant difference between the posttest data on mathematics learning outcomes in the experimental class and the control class. Moreover, based on descriptive data, the experimental class demonstrates superior mathematics learning outcomes compared to the control class. These findings suggest that the implemented Wordwall in the experimental class potentially contributes to enhanced mathematics learning outcomes when compared to traditional methods employed in the control class.

3.3. Effectiveness

In order to assess the efficacy of employing Wordwall on the mathematics learning outcomes of Phase E students, the computation of the effect size is conducted, as outlined in Table 8. This measurement enables a more profound comprehension of the magnitude and significance of Wordwall's impact on student learning outcomes, offering valuable insights for both educators and researchers. Through the quantification of the effect size, researchers can ascertain the practical significance of utilizing Wordwall as an educational tool to enhance mathematics learning outcomes within Phase E classrooms.

Table 8. Effect Size of Students' Mathematics Learning Outcomes

N_E	38
N_C	37
SD_E	7.76
SD_C	9.55
SD_{pooled}	8.69
$\bar{x}_E$	98.37
$\bar{x}_C$	93.43
ES	0.57

Based on the calculation results, the effectiveness of learning outcomes falls within the moderate criteria (0.57). The difference between this score and the strong category is quite significant. This is due to the minimal disparity between the average and data spread of the two classes.

In the implementation of Wordwall usage in the classroom, grouping is carried out due to the prohibition of mobile phone use in Indonesian schools [38], [39]. Students are only permitted to use laptops, although not all students have access to these devices. Consequently, the formation of groups becomes an alternative to ensure that all students can use Wordwall collectively. Using their laptops, student groups access the provided Wordwall link to solve various types of questions, including short form, multiple choice, or matching.

However, challenges arise when there is uneven participation among students within the groups. Only a portion of students actively completes Wordwall tasks. Furthermore, some students who could easily solve exercises in the textbook face confusion when using Wordwall. Students are not yet familiar with the presentation style [40], [41]. This indicates that students within each group exhibit diverse characteristics [42] and learning styles [43], [44], [45], underscoring the importance of considering learning styles before the initiation of interventions.

Moreover, it is advisable that Wordwall is designed not solely as an exercise tool but as a knowledge transformation instrument. The use of technology throughout the learning activities is believed to be more effective than its partial application. This strategy can enhance the effectiveness of Wordwall as an integral component of the educational process.

4. CONCLUSION

In conclusion, this study demonstrated a statistically significant difference (sig. 0.000 < 0.05) in the mean academic achievement of students who learned using Wordwall compared to those who did not. Descriptively, the experimental group exhibited higher average mathematics learning outcomes compared to the control group, with a moderate level of effectiveness (ES = 0.57). The heightened effectiveness of Wordwall can be achieved by utilizing it not only as a classroom exercise tool but also as a medium for knowledge transformation, taking into account the diverse learning styles of students.

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REFERENCES (10 PT)

[1] J. Engelbrecht, S. Llinares, and M. C. Borba, "Transformation of the mathematics classroom with the internet," *ZDM*, vol. 52, no. 5, pp. 825–841, Oct. 2020, doi: 10.1007/s11858-020-01176-4.

[2] Karcher, E. L., Wardwell,B., Ragland, E., York, A., Machaty, Z., Stewart, K.,Radcliffe, S., & Lott, E. A. (2023). Adapting theprogram redesign model for a student-centeredcurricula renewal in animal science.Natural SciencesEducation,52,e20105.https://doi.org/10.1002/nse2.20105

[3] Falbe, K.N., Seglem, R. Teaching Is Messy: Using Lesson Study to Reimagine Student-Centered Clinical Experiences. Educ. Sci. 2023, 13, 735. https://doi.org/10.3390/educsci13070735

[4] Tuval Avishai, Alik Palatnik. How teachers' knowledge and didactic contract evolve when transitioning to student-centered pedagogy - the case of project-based learning. Twelfth Congress of the European Society for Research in Mathematics Education (CERME12), Feb 2022, Bozen-Bolzano, Italy. hal-03748713.

[5] Iddrisu Baniham, Evelyn Kuusozume Yirbekyaa, & Anthony Bordoh. (2022). Teachers Perspective on Redesigning Social Studies Curriculum for Student-Centered and Constructivist Learning: Empirical Study of Secondary Schools, Northern Region. Social Education Research, 3(2), 307–321. https://doi.org/10.37256/ser.3220221676

[6] M. Lafuente-Lechuga, J. Cifuentes-Faura, and Ú. Faura-Martínez, "Mathematics Applied to the Economy and Sustainable Development Goals: A Necessary Relationship of Dependence," *Educ Sci (Basel)*, vol. 10, no. 11, p. 339, Nov. 2020, doi: 10.3390/educsci10110339.

[7] AlAli, R.; Alsoud, K.; Athamneh, F. Towards a Sustainable Future: Evaluating the Ability of STEM-Based Teaching in Achieving Sustainable Development Goals in Learning. Sustainability 2023, 15, 12542. https://doi.org/10.3390/su151612542

[8] J. Samuelsson, "Developing students' relationships with mathematics," *Educ Action Res*, vol. 31, no. 2, pp. 180–194, Mar. 2023, doi: 10.1080/09650792.2021.1899012.

[9] Polman, J., Hornstra, L. & Volman, M. The meaning of meaningful learning in mathematics in upper-primary education. Learning Environ Res 24, 469–486 (2021). https://doi.org/10.1007/s10984-020-09337-8

[10] F. Wang *et al.*, "Neural Cognitive Diagnosis for Intelligent Education Systems," *Proceedings of the AAAI Conference on Artificial Intelligence*, vol. 34, no. 04, pp. 6153–6161, Apr. 2020, doi: 10.1609/aaai.v34i04.6080.

[11] Camacho, A., Alves, R.A. & Boscolo, P. Writing Motivation in School: a Systematic Review of Empirical Research in the Early Twenty-First Century. Educ Psychol Rev 33, 213–247 (2021). https://doi.org/10.1007/s10648-020-09530-4

[12] Rafiola, R., Setyosari, P., Radjah, C. & Ramli, M. (2020). The Effect of Learning Motivation, Self-Efficacy, and Blended Learning on Students' Achievement in The Industrial Revolution 4.0. International Journal of Emerging Technologies in Learning (iJET), 15(8), 71-82. Kassel, Germany: International Journal of Emerging Technology in Learning. Retrieved February 1, 2024 from https://www.learntechlib.org/p/217073/.

[13] Coutinho, S.A., Neuman, G. A model of metacognition, achievement goal orientation, learning style and self-efficacy. Learning Environ Res 11, 131–151 (2008). https://doi.org/10.1007/s10984-008-9042-7

[14] Amal Alhadabi & Aryn C. Karpinski (2020) Grit, self-efficacy, achievement orientation goals, and academic performance in University students, International Journal of Adolescence and Youth, 25:1, 519-535, DOI: 10.1080/02673843.2019.1679202

[15] Hongbin Wu, Shan Li, Juan Zheng & Jianru Guo (2020) Medical students' motivation and academic performance: the mediating roles of self-efficacy and learning engagement, Medical Education Online, 25:1, DOI: 10.1080/10872981.2020.1742964

[16] Schunk, D.H., Mullen, C.A. (2012). Self-Efficacy as an Engaged Learner. In: Christenson, S., Reschly, A., Wylie, C. (eds) Handbook of Research on Student Engagement. Springer, Boston, MA. https://doi.org/10.1007/978-1-4614-2018-7_10

[17] S. Huang and N. Fang, "Predicting student academic performance in an engineering dynamics course: A comparison of four types of predictive mathematical models," *Comput Educ*, vol. 61, pp. 133–145, Feb. 2013, doi: 10.1016/j.compedu.2012.08.015.

[18] Toni Honicke, Jaclyn Broadbent & Matthew Fuller-Tyszkiewicz (2020) Learner self-efficacy, goal orientation, and academic achievement: exploring mediating and moderating relationships, Higher Education Research & Development, 39:4, 689-703, DOI: 10.1080/07294360.2019.1685941

[19] R. Raj *et al.*, "Professional Competencies in Computing Education," in *Proceedings of the 2021 Working Group Reports on Innovation and Technology in Computer Science Education*, New York, NY, USA: ACM, Dec. 2021, pp. 133–161. doi: 10.1145/3502870.3506570.

[20] G. P. TÜRKMEN and D. SOYBAŞ, "The Effect Of Gamification Method On Students' Achievements and Attitudes Towards Mathematics," *Bartın Üniversitesi Eğitim Fakültesi Dergisi*, vol. 8, no. 1, pp. 258–298, Feb. 2019, doi: 10.14686/buefad.424575.

[21] A. Manzano-León *et al.*, "Between Level Up and Game Over: A Systematic Literature Review of Gamification in Education," *Sustainability*, vol. 13, no. 4, p. 2247, Feb. 2021, doi: 10.3390/su13042247.

[22] E. Ceker and F. Ozdamli, "What 'Gamification' is and what it's not," *European Journal of Contemporary Education*, vol. 6, no. 2, pp. 221–228, Jun. 2017, doi: 10.13187/ejced.2017.2.221.

[23] L. M. Carmona-Chica and A. L. Argudo-Garzón, "Vocabulary skills and virtual tools in students of A2 Universidad Católica de Cuenca," *Revista Arbitrada Interdisciplinaria Koinonía*, vol. 7, no. 1, p. 23, Jun. 2022, doi: 10.35381/r.k.v7i1.1677.

[24] Chandra Segaran, V., & Hashim, H. (2022). 'More Online Quizzes, Please!' The Effectiveness of Online Quiz Tools in Enhancing the Learning of Grammar among ESL Learners. International Journal of Academic Research in Business and Social Sciences. DOI:10.6007/ijarbss/v12-i1/12064.

[25] A. Bilova, "IMPLEMENTING ENJOYABLE LEARNING STRATEGY WITH WORDWALL IN THE EFL CLASSROOM", Anglistics and Americanistics, vol. 1, no. 20, pp. 58-64, Jun. 2023. https://doi.org/https://doi.org/10.15421/382308

[26] Chans GM, Portuguez Castro M. Gamification as a Strategy to Increase Motivation and Engagement in Higher Education Chemistry Students. Computers. 2021; 10(10):132. https://doi.org/10.3390/computers10100132

[27] T. K. Rahma *et al.*, "Using wordwall as a gamification-based mathematics learning material to support students' learning activities," 2023, p. 020043. doi: 10.1063/5.0141610.

[28] Kurniawan, H, Supriyono, Tursilowati, & Kustiningsih, I. J. (2021). Action Research: CPA Math Word Wall Group Competition to Improve Conceptual Understanding in Algebra Problem Solving Activities. 2nd International Conference on Education and

Technology (ICETECH 2021). Advances in Social Science, Education and Humanities Research. Atlantis Press. 10.2991/assehr.k.220103.051
[29] C. Rodrigues-Escobar, J. Cuevas-Lepe, and L. Maluenda-Parragues, "Assessing the Effectiveness of Wordwall.net as a Vocabulary Learning Tool: Pre-Service EFL Teachers' Perspectives," *Journal of Education and Practice*, vol. 14, no. 31, 2023. DOI: 10.7176/JEP/14-31-04
[30] M. Palioura and C. Dimoulas, "Digital Storytelling in Education: A Transmedia Integration Approach for the Non-Developers," *Educ Sci (Basel)*, vol. 12, no. 8, p. 559, Aug. 2022, doi: 10.3390/educsci12080559.
[31] C. S. Hibaya, T. Pasawano, and T. Sottiwan, *Development of Online Lesson to Enhance Mathematics Achievement for Grade 3 Students*, vol. 4. Thailand: King Mongkut's Instituteof Technology Ladkrabang Princeof Chumphon Campus, 2023.
[32] S. Sudarsono and Sapriya, "Development Of Web-Based Interactive Game Media Application Wordwall Material Odd Numbers Even Mathematics Subjects Grade Ii Elementary School," *Proceeding The 5th International Conference On Elementary Education*, vol. 5, no. 1, pp. 629–639, 2023.
[33] E. Shafwa and A. Hikmat, "The Effectiveness of Evaluation of Mathematics Learning Using Wordwall Media in Elementary School," *Scaffolding: Jurnal Pendidikan Islam dan Multikulturalisme*, vol. 5, no. 3, pp. 1–12, Aug. 2023, doi: 10.37680/scaffolding.v5i2.3406.
[34] K. I. Lestari, I. N. Arcana, A. E. Susetyo, and K. S. Kuncoro, "Development of Online Learning Quiz and Educational Game Using Word Walls in Mathematics for Grade 10," *INSANIA : Jurnal Pemikiran Alternatif Kependidikan*, vol. 27, no. 2, pp. 145–159, Dec. 2022, doi: 10.24090/insania.v27i2.6924.
[35] M. Bueno, F. Perez, R. Valerio, and E. M. Q. Areola, "A Usability Study on Google Site and Wordwall.net: Online Instructional Tools for Learning Basic Integration Amid Pandemic," *Journal of Global Business and Social Entrepreneurship (GBSE)*, vol. 7, no. 23, pp. 61–71, 2022. http://gbse.my/V8%20NO.23%20(JANUARY%202022)/Paper-288-.pdf
[36] John W. Creswell, *Educational research : planning, conducting, and evaluating quantitative and qualitative research*, 4th ed. Boston: Pearson, 2012.
[37] C.C. Serdar, M. Cihan, D. Yücel and M.A. Serdar, "Sample size, power and effect size revisited: simplified and practical approaches in pre-clinical, clinical and laboratory studies", Biochemia Medica, vol.31, no. 1, pp. 27-53, 2021. https://doi.org/10.11613/BM.2021.010502.
[38] Cohen L., L. Manion, and K. Morrison, *Research Methods in Education*. New York: Routledge, 2017.
[39] M. Suseno, B. Hayat, M.D.K. Putra, J.K. Bien, R. Rachmawati, and H. Hartanto, "A Differential Item Functioning (DIF) Analysis of The Mobile Phone Problem Use Scale in Indonesian Schools With and Without Smartphone Banned Policy," *Cogent Psychology*, vol. 9, no. 1, Oct. 2022, https://doi.org/10.1080/23311908.2022.2137306.
[40] Zaenal Abidin, Anuradha Mathrani, Roberta Hunter & David Parsons (2017) Challenges of Integrating Mobile Technology into Mathematics Instruction in Secondary Schools: An Indonesian Context, Computers in the Schools, 34:3, 207-222, DOI: 10.1080/07380569.2017.1344056
[41] S. Asgari, J. Trajkovic, M. Rahmani, W. Zhang, R. C. Lo, and A. Sciortino, "An observational study of engineering online education during the COVID-19 pandemic," *PLoS One*, vol. 16, no. 4, p. e0250041, Apr. 2021, doi: 10.1371/journal.pone.0250041.
[42] A. Selvaraj, V. Radhin, N. KA, N. Benson, and A. J. Mathew, "Effect of pandemic based online education on teaching and learning system," *Int J Educ Dev*, vol. 85, p. 102444, Sep. 2021, doi: 10.1016/j.ijedudev.2021.102444.
[43] S. Zhang, Y. Wen, and Q. Liu, "Exploring student teachers' social knowledge construction behaviors and collective agency in an online collaborative learning environment," *Interactive Learning Environments*, vol. 30, no. 3, pp. 539–551, Feb. 2022, doi: 10.1080/10494820.2019.1674880.
[44] F. Rasheed and A. Wahid, "Learning style detection in E-learning systems using machine learning techniques," *Expert Syst Appl*, vol. 174, p. 114774, Jul. 2021, doi: 10.1016/j.eswa.2021.114774.
[45] M. A. Hassan, U. Habiba, F. Majeed & M. Shoaib "Adaptive gamification in e-learning based on students' learning styles,' *Interactive Learning Environments*, 29:4, 545-565, Mar 2019, DOI: 10.1080/10494820.2019.1588745

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3. Bukti konfirmasi permintaan revisi yang ketiga dan submit revisi yang ketiga (24 Juli 2024)

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[IJERE] Editor Decision

3 messages

Dr. Lina Handayani <ijere@iaescore.com> Wed, Jul 24, 2024 at 3:10 PM
Reply-To: "Dr. Lina Handayani" <linafkm@gmail.com>
To: Sindi Amelia <sindiamelia88@edu.uir.ac.id>
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The following message is being delivered on behalf of International Journal of Evaluation and Research in Education (IJERE).

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Dear Prof/Dr/Mr/Mrs: Sindi Amelia,

We have reached a decision regarding your submission entitled "Enhancing Mathematics Learning in Phase E: Evaluating the Effectiveness of the Wordwall Game" to International Journal of Evaluation and Research in Education (IJERE), a SCOPUS (https://www.scopus.com/sourceid/21100934092) and ERIC indexed journal (https://bit.ly/2El8hDj).

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Please prepare your revised paper (in MS Word or LATEX file format) adheres every detail of the guide of authors (https://iaescore.com/gfa/ijere.docx for MS Word file format, or https://iaescore.com/gfa/ijere.rar for LATEX file format), and check it for spelling/grammatical mistakes.

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==========
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I would like to thank the reviewers for their insightful feedback. All comments from Reviewer 1 are highlighted in yellow, those from Reviewer 2 are highlighted in red, and those from Reviewer 3 are highlighted in green.

Reviewer 1

Comment 1: There are some references that are not required.
Response: We thoroughly updated our references; 5 references were eliminated, and two were replaced by more recent publications.

Comment 2: The presentation of Figures 2 and 3 should be improved.
Response: The necessary adjustments have been made.

Comment 3: Equation (2) seems to be incorrect.
Response: Equation (2) is correct. This can be proven as follows:...
In order to clarify equation 9 in the manuscript, the following remarks have been added... etc.

All changes for reviewer 1 are highlighted in yellow in the main text.

Reviewer 2

Comment 1:
Response:

Comment 2:
Response:

Comment 3:
Response:

All changes for reviewer 2 are highlighted in red in the main text.

Etc.

Such a document clarifies everything and will aid the reviewers in evaluating the work fast.
When providing your amended primary document files, you must also upload your corrections statement. Before your manuscript, the declaration of revisions should appear.

Reviewer B:

The IJERE form to evaluate submitted papers
Content:
Good

Significance:
Very good

Originality:
Good

Relevance:
Good

Presentation:
Very good

Recommendation:
Good

Comments to the Author

This comment will be visible to the Author
:

Overall, the paper entitled "Enhancing Mathematics Learning in Phase E: Assessing Wordwall Effectiveness" is very good and well organized. However, this paper has shortcomings in its appearance, so this paper needs a little improvement in its appearance.

In the Method section: explain how you determined the sample size. Support with the reference whether the sample size is adequate.
Explain the validity and reliability of your questionnaire/instrument
- please update references in recent 5 years.

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sindi amelia <sindiamelia88@edu.uir.ac.id> Sun, Jul 28, 2024 at 4:53 PM
To: "Dr. Lina Handayani" <linafkm@gmail.com>

Thank you for your email and for considering my submission. I will submit the revised paper within the 6-week timeframe.
[Quoted text hidden]

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sindi amelia <sindiamelia88@edu.uir.ac.id> Fri, Aug 23, 2024 at 6:20 AM
To: "Dr. Lina Handayani" <linafkm@gmail.com>

Dear Editor,

Thank you for your valuable feedback on our manuscript. Based on the first review, the title has been revised to "Enhancing Mathematics Learning in Phase E: Assessing Wordwall Effectiveness." We have carefully reviewed your latest suggestions and made the necessary revisions.

1. **References**: We have added three additional references from the recommended journals (12, 22, and 23). Additionally, all references have been updated to ensure they are within the last five years (14, 17, 18, 25, and 43), except for textbooks (39 and 41), which remain relevant to the study.

2. **Methodology**: We have further clarified the sampling method, including information of how the sample size was determined.

The revised article has been submitted through the OJS platform. We believe these updates address the concerns raised, and we hope the revised manuscript meets the standards of the International Journal of Evaluation and Research in Education.

Thank you for your time and consideration.

Best regards,
Sindi Amelia

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Enhancing Mathematics Learning in Phase E: Assessing Wordwall Effectiveness

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ABSTRACT

The use of technology, classroom atmosphere, facilities, and learning resources can support quality learning outcomes in students. Wordwall, as a gamification tool, has been proven to be effective for elementary and junior high school students in mathematics. However, the effectiveness of Wordwall in enhancing senior high school students' cognitive abilities in mathematics learning has not been investigated. Previous studies have only shown its effectiveness in improving affective abilities. Therefore, This study endeavors to evaluate the effects of using Wordwall on the mathematics learning outcomes of senior high school students in Phase E. Through quasi-experimental research with pre- and posttest group design, 38 experimental class students and 37 control class students were selected as samples in this study. The study found a statistically significant difference (sig. 0.000<0.05) in the mean learning outcomes of students who used Wordwall compared to those who did not. Descriptively, The experimental group displayed superior average mathematics learning outcomes compared to the control group, demonstrating a moderate level of effectiveness (ES=0.57). The strong effect of Wordwall can be realized if it is used not only as an exercise tool within the classroom but also as an instrument for knowledge transformation, incorporating consideration of students' learning styles.

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1. INTRODUCTION

Science and technology discipline is currently advancing rapidly, influencing various aspects of human life, including education. Since the 1970s, technology has transformed mathematics education and will undoubtedly play a major role in shaping the future of education compared to today. Educators realize the necessity to reconsider the entire education model and redesign it to be more student-centered [1], [2], [3], [4], [5].

Mathematics profoundly influences the attainment of the Sustainable Development Goals (SDGs). Simultaneously, these goals facilitate the exploration of real-life situations within the realm of mathematics, fostering active learning for students [6], [7]. In this context, each learning objective in a mathematics lesson is linked to something meaningful for the students, incorporating aspects of their daily lives [8], [9]. Therefore, mathematics education can genuinely prepare human resources to compete in the global era.

The obtained information reveals that the teaching and learning process lacks integration with technology. Consequently, students experience demotivation due to feelings of monotony and boredom associated with book-based learning and the limited communicative role of teachers. Low motivation leads to

a decline in academic achievement [10], [11], [12], [13]. To improve academic performance, students must consider Psychological aspects such as learning preferences, self-efficacy, and goals for achievement [14], motivation [15], [16], interests [17], and the teaching and learning environment [18], [19].

Academic performance fundamentally encompasses skills related to knowledge, skills, attitudes, and values manifested in habits of thinking and behaving. Experiencing understanding "in action" involves integrating content knowledge and cognitive competencies with the demonstration of perspective, empathy, and self-awareness—qualities collectively termed as professional dispositions [20]. A potential remedy to enhance engagement and motivation in students involves the adoption of gamification. Gamification represents an approach that incorporates game components outside the typical gaming environment [21], [22], [23], [24], [25].

Utilizing virtual gamification platforms like Wordwall.net holds the potential to heighten students' interest in their learning processes [26], [27], [28]. This approach is considered highly suitable for mathematics students, fostering engagement in various learning activities [29], [30]. Wordwall, functioning as an educational technology tool, is intentionally designed to facilitate interactive learning in diverse settings. It empowers both educators and learners to create personalized interactive materials, thereby enriching individual and collaborative learning experiences. These interactive resources are applicable in various pedagogical contexts, including formative assessment and gamified learning.

The Wordwall tool offers a wide array of templates, such as quizzes, matching exercises, word searches, and crossword puzzles, all of which can be customized to meet users' specific needs. Noteworthy characteristics also encompass its accessibility, adaptability, and the potential for collaboration between student and teacher teams [31]. Wordwall is accessible via any web-enabled device, encompassing interactive whiteboards, tablets, desktop and portable computers, or smartphones. Its simplicity makes it user-friendly, facilitating easy operation for average users [32].

Several studies have developed instructional materials for mathematics using Wordwall, spanning from elementary to high school levels. While these materials have undergone valid and practical testing, not all products have been tested for effectiveness. Only a limited number of studies have investigated the effectiveness of using Wordwall in mathematics education, and these studies have been limited to elementary [33], [34], [35] and junior high school [30] levels.

Regarding senior high school levels, the efficacy of Wordwall instructional materials tends to measure affective abilities, such as motivation and interest [36], as well as interactions among students [37]. No research has yet explored the effectiveness of Wordwall in enhancing mathematics learning outcomes at the senior high school or Phase E level. Thus, this gap in the literature serves as the basis for conducting the present study. The current investigation addresses the following two research inquiries: 1) Is there an influence on the mathematics learning outcomes of Phase E students after utilizing the Wordwall game for instruction? 2) What is the effectiveness of implementing the Wordwall game in improving the mathematics learning achievements among Phase E students in mathematics instruction?

2. METHOD

Quantitative approaches with a quasi-experimental design, as delineated in Table 1, are utilized in the methodology of this study [38]. The research was conducted from September 29, 2023, to November 10, 2023, at SMAN 4 Pekanbaru, Riau Province, Indonesia. All 11 classes of tenth-grade students at SMAN 4 Pekanbaru constituted the population for this study. The sample was randomly selected in groups to obtain two representative classes. This selection was facilitated using Wordwall to ensure the presence of the Wordwall usage atmosphere earlier.

Table 1. Pre- and Posttest Design

Select Control Group	Pretest	No Treatment	Posttest
Select Experimental Group	Pretest	Wordwall Treatment	Posttest

The data collection instrument utilized in this research is specifically designed to evaluate the mathematics learning outcomes of students through the implementation of the Wordwall mathematical game. The Wordwall instructional tool used pertains to topics such as exponential functions and system of linear equations with two variables, which have been validated and proven practical [39]. The data collection instruments employed consist of pre- and posttest questions. The Pretest questions were administered to assess students' mathematics learning outcomes before any treatment was applied to both classes, while the posttest questions were utilized to evaluate their outcomes after undergoing distinct treatments.

A testing technique was employed as the data collection method in this study. This technique was utilized to obtain data regarding the students' initial abilities before any treatment, which would be acquired

through pretest sheets conducted at the beginning of the session, and after the treatment, which would be obtained through posttest sheets conducted at the end of the session. The test results obtained were analyzed using both descriptive and inferential analyses. In the descriptive data analysis, the researcher examined the mean, standard deviation, as well as the minimum and maximum scores of students' mathematics learning outcomes. In inferential data analysis, the researcher observed the differences in students' learning outcomes using the assistance of SPSS v.25.

In addition to statistical tests, this study also employed a data analysis technique to find out the effectiveness of implementing the Wordwall Game on students' mathematics learning outcomes when compared to conventional learning. This assessment will be measured using a metric known as Effect Size. The formula and criteria for Effect Size (ES) used are as follows [40]:

$$ES = \frac{Mean\ of\ experimental\ group - mean\ of\ control\ group}{pooled\ standard\ deviation} \quad (1)$$

To calculate the pooled deviation, the formula should be:

$$SD_{pooled} = \sqrt{\frac{(N_E-1)SD_E{}^2+(N_C-1)SD_C{}^2}{N_E+N_C-2}} \quad (2)$$

Where N_E = number in the experimental group, N_C = number in the control group, SD_E = standard deviation of the experimental group, and SD_C = standard deviation of the control group. The results of the effect size (ES) calculation are interpreted as shown in Table 2.

Table 2. Criteria of Effect Size

Criteria	Interpretation
$ES \leq 0.20$	Weak Effect
$0.20 < ES \leq 0.50$	Modest Effect
$0.50 < ES \leq 1.00$	Moderate Effect
$ES > 1.00$	Strong Effect

3. RESULTS AND DISCUSSION

3.1. Descriptive Statistical Analysis

The pretest and posttest data collected are analyzed descriptively to calculate the average, standard deviation, lowest value, and highest value. These statistical measures provide a comprehensive understanding of the distribution and central tendencies within the dataset. A summary of the results of the descriptive analysis of pretest and posttest data for Phase E students is presented in Table 3.

Table 3. Description of Pre- and Posttest Data of Students' Mathematics Learning Outcomes

Descriptive Statistics	Pretest		Posttest	
	Experimental Group	Control Group	Experimental Group	Control Group
N	38	37	38	37
$\bar{X}$	27.01	28.13	98.37	93.43
SD	17.81	12.82	7.76	9.55
Min	0	0	52	48
Max	63	41	100	100

According to the data presented in Table 3, it is evident descriptively that the mean mathematics learning achievements of students in both classes before the use of Wordwall in one class tend to be similar, with better data spread in the control class. The data in the experimental class (17.81) have a wider spread compared to the data in the control class (12.82). This difference arises because both classes have the same minimum value, but students who achieved the highest score were in the experimental class (63) with a significant difference of 22 points compared to the highest score in the control class.

After implementing Wordwall, there is a descriptive superiority in the mean mathematics learning achievement of students in the experimental class (98.37) compared to the control class, with an approximate 5-point difference in the average scores favoring the experimental group. The experimental class demonstrates a narrower data spread compared to the control class, as indicated by the smaller range observed in the experimental class (48) in contrast to the range observed in the control class (52). In essence, initially, both classes seemed to have the same quality. However, after the implementation of Wordwall in the experimental class, the learning outcome improved.

3.2. Inferential Statistical Analysis

Subsequently, to investigate the research inquiries, inferential statistical methods were applied to analyze the data. However, before conducting these statistical tests, assumption tests were performed, namely tests for normality and homogeneity of variance. The test of normality was conducted as a requirement for analysis of variance, while the variance homogeneity test was performed as a requirement for the t-test. If the data did not follow a normal distribution, a nonparametric test, specifically the Mann-Whitney test, would be employed without going through the homogeneity test series. The findings of the normality assessment for the pretest data of students in both instructional cohorts are depicted in Table 4.

Table 4. Normality Test of Pretest Data on Students' Mathematics Learning Outcomes

Shapiro-Wilk	Experimental Class	Control Class
Stat.	0.945	0.778
Df	38	37
Sig.	0.060	0.000

H_0: The sample is selected from a population exhibiting a normal distribution pattern.
H_1: The sample is selected from a population that is not exhibiting a normal distribution

The criterion used for testing is that if the p-value (Sig.) exceeds the predetermined significance level ($\propto = 0.05$), then H_0 is accepted; otherwise, H_0 is rejected. The normality test employed is the Shapiro-Wilk test, as the data size exceeds 30. In the table, it is evident that the probability value (sig.) for one of the datasets is below 0.05. This implies that H_0 is rejected, leading to the conclusion that the data for both groups do not follow a normal distribution. Consequently, the equivalence test for pretest data on student's mathematics learning achievements employs a non-parametric test, specifically the Mann-Whitney test, the outcomes of which are detailed in Table 5.

Table 5. Test of Equality of Pretest Data of Student's Mathematics Learning Outcome

Mann-Whitney	Z	Sig. (2-tailed)	H_0
612.000	-0.965	0.335	Accepted

$H_0: \mu_1 = \mu_2$
$H_1: \mu_1 \neq \mu_2$
where: μ_1 = average pretest data for mathematics learning achievement of students using Wordwall and μ_2 = average pretest data for mathematics learning achievement of students not using Wordwall.

The testing criterion utilized is that if the p-value (Sig.) exceeds the threshold of 0.05, then H_0 is accepted; otherwise, H_0 is rejected. In the table, it is noted that the probability value (sig.) exceeds 0.05, thus H_0 is accepted. Consequently, there exists no disparity between the pretest data concerning mathematics learning achievements within the experimental class and the control class. After statistically confirming that both classes have the same average test scores, the next step is to analyze the post-test data to determine whether Wordwall has an effect on mathematics student learning outcomes. This analysis begins with a normality test, as depicted in Table 6.

Table 6. Normality Test of Posttest Data on Students' Mathematics Learning Outcomes

Shapiro-Wilk	Eksperimen	Kontrol
Stat.	0.203	0.614
Df	38	37
Sig.	0.000	0.000

H_0: The sample is selected from a population exhibiting a normal distribution pattern.
H_1: The sample is selected from a population that is not exhibiting a normal distribution.

Based on Table 6, it is evident that the probability value (sig.) for one of the datasets is below 0.05. Therefore, H_0 is rejected, indicating that the data for these two groups are not normally distributed. Consequently, the comparison of posttest data concerning students' mathematics learning achievements utilizes the Mann-Whitney test. The result is presented in Table 7.

Table 7. Test of Equality of Posttest Data of Students' Mathematics Learning Outcome

Mann-Whitney	Z	Sig. (2-tailed)	H_0
210.000	-5.480	0.000	Rejected

$H_0: \mu_1 = \mu_2$
$H_1: \mu_1 \neq \mu_2$
where: μ_1 = average posttest data for mathematics learning achievement of students using Wordwall and μ_2 = average posttest data for mathematics learning achievement of students not using Wordwall.

According to the data presented in the table, a probability value (sig.) being below 0.05 leads to rejecting the null hypothesis (H_0), suggesting a significant difference between the posttest data on mathematics learning outcomes in the experimental class and the control class. Moreover, based on descriptive data, the experimental class demonstrates superior mathematics learning outcomes compared to the control class. These findings suggest that the implemented Wordwall in the experimental class potentially contributes to enhanced mathematics learning outcomes when compared to traditional methods employed in the control class.

3.3. Effectiveness

In order to assess the efficacy of employing Wordwall on the mathematics learning outcomes of Phase E students, the computation of the effect size is conducted, as outlined in Table 8. This measurement enables a more profound comprehension of the magnitude and significance of Wordwall's impact on student learning outcomes, offering valuable insights for both educators and researchers. Through the quantification of the effect size, researchers can ascertain the practical significance of utilizing Wordwall as an educational tool to enhance mathematics learning outcomes within Phase E classrooms.

Table 8. Effect Size of Students' Mathematics Learning Outcomes

N_E	38
N_C	37
SD_E	7.76
SD_C	9.55
SD_{pooled}	8.69
$\bar{x}_E$	98.37
$\bar{x}_C$	93.43
ES	0.57

Based on the calculation results, the effectiveness of learning outcomes falls within the moderate criteria (0.57). The difference between this score and the strong category is quite significant. This is due to the minimal disparity between the average and data spread of the two classes.

In the implementation of Wordwall usage in the classroom, grouping is carried out due to the prohibition of mobile phone use in Indonesian schools [41], [42]. Students are only permitted to use laptops, although not all students have access to these devices. Consequently, the formation of groups becomes an alternative to ensure that all students can use Wordwall collectively. Using their laptops, student groups access the provided Wordwall link to solve various types of questions, including short form, multiple choice, or matching.

However, challenges arise when there is uneven participation among students within the groups. Only a portion of students actively completes Wordwall tasks. Furthermore, some students who could easily solve exercises in the textbook face confusion when using Wordwall. Students are not yet familiar with the presentation style [43], [44]. This indicates that students within each group exhibit diverse characteristics [45] and learning styles [46], [47], [48], underscoring the importance of considering learning styles before the initiation of interventions.

Moreover, it is advisable that Wordwall is designed not solely as an exercise tool but as a knowledge transformation instrument. The use of technology throughout the learning activities is believed to be more effective than its partial application. This strategy can enhance the effectiveness of Wordwall as an integral component of the educational process.

4. CONCLUSION

In conclusion, this study demonstrated a statistically significant difference (sig. 0.000 < 0.05) in the mean academic achievement of students who learned using Wordwall compared to those who did not. Descriptively, the experimental group exhibited higher average mathematics learning outcomes compared to the control group, with a moderate level of effectiveness (ES = 0.57). The heightened effectiveness of Wordwall can be achieved by utilizing it not only as a classroom exercise tool but also as a medium for knowledge transformation, taking into account the diverse learning styles of students.

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REFERENCES (10 PT)

[1] J. Engelbrecht, S. Llinares, and M. C. Borba, "Transformation of the mathematics classroom with the internet," *ZDM*, vol. 52, no. 5, pp. 825–841, Oct. 2020, doi: 10.1007/s11858-020-01176-4.

[2] Karcher, E. L., Wardwell,B., Ragland, E., York, A., Machaty, Z., Stewart, K.,Radcliffe, S., & Lott, E. A. (2023). Adapting theprogram redesign model for a student-centeredcurricula renewal in animal science.Natural SciencesEducation,52,e20105.https://doi.org/10.1002/nse2.20105

[3] Falbe, K.N.; Seglem, R. Teaching Is Messy: Using Lesson Study to Reimagine Student-Centered Clinical Experiences. Educ. Sci. 2023, 13, 735. https://doi.org/10.3390/educsci13070735

[4] Tuval Avishai, Alik Palatnik. How teachers' knowledge and didactic contract evolve when transitioning to student-centered pedagogy - the case of project-based learning. Twelfth Congress of the European Society for Research in Mathematics Education (CERME12), Feb 2022, Bozen-Bolzano, Italy. hal-03748713.

[5] Iddrisu Bariham, Evelyn Kuusozume Yirbekyaa, & Anthony Bordoh. (2022). Teachers Perspective on Redesigning Social Studies Curriculum for Student-Centered and Constructivist Learning: Empirical Study of Secondary Schools, Northern Region. Social Education Research, 3(2), 307–321. https://doi.org/10.37256/ser.3220221676

[6] M. Lafuente-Lechuga, J. Cifuentes-Faura, and Ú. Faura-Martínez, "Mathematics Applied to the Economy and Sustainable Development Goals: A Necessary Relationship of Dependence," *Educ Sci (Basel)*, vol. 10, no. 11, p. 339, Nov. 2020, doi: 10.3390/educsci10110339.

[7] AlAli, R.; Alsoud, K.; Athamneh, F. Towards a Sustainable Future: Evaluating the Ability of STEM-Based Teaching in Achieving Sustainable Development Goals in Learning. Sustainability 2023, 15, 12542. https://doi.org/10.3390/su151612542

[8] J. Samuelsson, "Developing students' relationships with mathematics," *Educ Action Res*, vol. 31, no. 2, pp. 180–194, Mar. 2023, doi: 10.1080/09650792.2021.1899012.

[9] Polman, J., Hornstra, L. & Volman, M. The meaning of meaningful learning in mathematics in upper-primary education. Learning Environ Res 24, 469–486 (2021). https://doi.org/10.1007/s10984-020-09337-8

[10] F. Wang *et al.*, "Neural Cognitive Diagnosis for Intelligent Education Systems," *Proceedings of the AAAI Conference on Artificial Intelligence*, vol. 34, no. 04, pp. 6153–6161, Apr. 2020, doi: 10.1609/aaai.v34i04.6080.

[11] Camacho, A., Alves, R.A. & Boscolo, P. Writing Motivation in School: a Systematic Review of Empirical Research in the Early Twenty-First Century. Educ Psychol Rev 33, 213–247 (2021). https://doi.org/10.1007/s10648-020-09530-4

[12] T. Tanti, M. Maison, B. Syefrinando, M. Daryanto, and H. Salma, 'Students' self-regulation and motivation in learning science', Int. J. Eval. Res. Educ. IJERE, vol. 9, no. 4, p. 865, Dec. 2020, doi: 10.11591/ijere.v9i4.20657

[13] Rafiola, R., Setyosari, P., Radjah, C. & Ramli, M. (2020). The Effect of Learning Motivation, Self-Efficacy, and Blended Learning on Students' Achievement in The Industrial Revolution 4.0. International Journal of Emerging Technologies in Learning (iJET), 15(8), 71-82. Kassel, Germany: International Journal of Emerging Technology in Learning. Retrieved February 1, 2024 from https://www.learntechlib.org/p/217073/.

[14] Y. Wang, L. Tian, and E. Scott Huebner, 'Basic psychological needs satisfaction at school, behavioral school engagement, and academic achievement: Longitudinal reciprocal relations among elementary school students', Contemporary Educational Psychology, vol. 56, pp. 130–139, Jan. 2019, doi: 10.1016/j.cedpsych.2019.01.003.

[15] Amal Alhadabi & Aryn C. Karpinski (2020) Grit, self-efficacy, achievement orientation goals, and academic performance in University students, International Journal of Adolescence and Youth, 25:1, 519-535, DOI: 10.1080/02673843.2019.1679202

[16] Hongbin Wu, Shan Li, Juan Zheng & Jianru Guo (2020) Medical students' motivation and academic performance: the mediating roles of self-efficacy and learning engagement, Medical Education Online, 25:1, DOI: 10.1080/10872981.2020.1742964

[17] Mazana, Yahya Mzomwe. Suero Montero, Calkin. Olifage, Casmir Respickius. (2019). Investigating Students' Attitude towards Learning Mathematics. International Electronic Journal of Mathematics Education, 14 (1) , 207-231. 10.29333/iejme/3997.

[18] N. A. Abdulrahim and M. J. Orosco, 'Culturally Responsive Mathematics Teaching: A Research Synthesis', Urban Rev, vol. 52, no. 1, pp. 1–25, Mar. 2020, doi: 10.1007/s11256-019-00509-2.

[19] Toni Honicke, Jaclyn Broadbent & Matthew Fuller-Tyszkiewicz (2020) Learner self-efficacy, goal orientation, and academic achievement: exploring mediating and moderating relationships, Higher Education Research & Development, 39:4, 689-703, DOI: 10.1080/07294360.2019.1685941

[20] R. Raj *et al.*, "Professional Competencies in Computing Education," in *Proceedings of the 2021 Working Group Reports on Innovation and Technology in Computer Science Education*, New York, NY, USA: ACM, Dec. 2021, pp. 133–161. doi: 10.1145/3502870.3506570.

[21] G. P. TÜRKMEN and D. SOYBAŞ, "The Effect Of Gamification Method On Students' Achievements and Attitudes Towards Mathematics," *Bartın Üniversitesi Eğitim Fakültesi Dergisi*, vol. 8, no. 1, pp. 258–298, Feb. 2019, doi: 10.14686/buefad.424575.

[22] Q. Aini, N. Azizah, R. Salam, N. P. L. Santoso, and S. Millah, 'iLearning education based on gamification blockchain', Indones. J. Electr. Eng. Comput. Sci., vol. 26, no. 1, p. 531, Apr. 2022, doi: 10.11591/ijeecs.v26.i1.pp531-538.

[23] F. A. Pratama, R. M. Silitonga, and Y.-T. Jou, 'Rimigs: the impact of gamification on students' motivation and performance in programming class', Indones. J. Electr. Eng. Comput. Sci., vol. 24, no. 3, p. 1789, Dec. 2021, doi: 10.11591/ijeecs.v24.i3.pp1789-1795.

[24] A. Manzano-León *et al.*, "Between Level Up and Game Over: A Systematic Literature Review of Gamification in Education," *Sustainability*, vol. 13, no. 4, p. 2247, Feb. 2021, doi: 10.3390/su13042247.

[25] Rauschenberger, M., Willems, A., Temieden, M. & Thomaschewski, J. (2019). Towards the use of gamification frameworks in learning environments. Journal of Interactive Learning Research, 30(2), 147-165. Waynesville, NC: Association for the Advancement of Computing in Education (AACE). Retrieved August 18, 2024 from https://www.learntechlib.org/primary/p/181283/.

[26] L. M. Carmona-Chica and A. L. Argudo-Garzón, "Vocabulary skills and virtual tools in students of A2 Universidad Católica de Cuenca," *Revista Arbitrada Interdisciplinaria Koinonía*, vol. 7, no. 1, p. 23, Jun. 2022, doi: 10.35381/r.k.v7i1.1677.

[27] Chandra Segaran, V., & Hashim, H. (2022). 'More Online Quizzes, Please!' The Effectiveness of Online Quiz Tools in Enhancing the Learning of Grammar among ESL Learners. International Journal of Academic Research in Business and Social Sciences. DOI:10.6007/ijarbss/v12-i1/12064.

[28] A. Bilova, "IMPLEMENTING ENJOYABLE LEARNING STRATEGY WITH WORDWALL IN THE EFL CLASSROOM", Anglistics and Americanistics, vol. 1, no. 20, pp. 58-64, Jun. 2023. https://doi.org/https://doi.org/10.15421/382308

[29] Chans GM, Portuguez Castro M. Gamification as a Strategy to Increase Motivation and Engagement in Higher Education Chemistry Students. Computers. 2021; 10(10):132. https://doi.org/10.3390/computers10100132

[30] T. K. Rahma *et al.*, "Using wordwall as a gamification-based mathematics learning material to support students' learning activities," 2023, p. 020043. doi: 10.1063/5.0141610.
[31] Kurniawan, H, Supriyono, Tursilowati, & Kustiningsih, I. J. (2021). Action Research: CPA Math Word Wall Group Competition to Improve Conceptual Understanding in Algebra Problem Solving Activities. 2nd International Conference on Education and Technology (ICETECH 2021). Advances in Social Science, Education and Humanities Research. Atlantis Press. 10.2991/assehr.k.220103.051
[32] C. Rodrigues-Escobar, J. Cuevas-Lepe, and L. Maluenda-Parragues, "Assessing the Effectiveness of Wordwall.net as a Vocabulary Learning Tool: Pre-Service EFL Teachers' Perspectives," *Journal of Education and Practice*, vol. 14, no. 31, 2023. DOI: 10.7176/JEP/14-31-04
[33] M. Pahoura and C. Dimoulas, "Digital Storytelling in Education: A Transmedia Integration Approach for the Non-Developers," *Educ Sci (Basel)*, vol. 12, no. 8, p. 559, Aug. 2022, doi: 10.3390/educsci12080559.
[34] C. S. Hibaya, T. Pasawano, and T. Sottiwan, *Development of Online Lesson to Enhance Mathematics Achievement for Grade 3 Students*, vol. 4. Thailand: King Mongkut's Instituteof Technology Ladkrabang Princeof Chumphon Campus, 2023.
[35] S. Sudarsono and Sapriya, "Development Of Web-Based Interactive Game Media Application Wordwall Material Odd Numbers Even Mathematics Subjects Grade Ii Elementary School," *Proceeding The 5th International Conference On Elementary Education*, vol. 5, no. 1, pp. 629–639, 2023.
[36] E. Shafwa and A. Hikmat, "The Effectiveness of Evaluation of Mathematics Learning Using Wordwall Media in Elementary School," *Scaffolding: Jurnal Pendidikan Islam dan Multikulturalisme*, vol. 5, no. 3, pp. 1–12, Aug. 2023, doi: 10.37680/scaffolding.v5i2.3406.
[37] K. I. Lestari, I. N. Arcana, A. E. Susetyo, and K. S. Kuncoro, "Development of Online Learning Quiz and Educational Game Using Word Walls in Mathematics for Grade 10," *INSANIA : Jurnal Pemikiran Alternatif Kependidikan*, vol. 27, no. 2, pp. 145–159, Dec. 2022, doi: 10.24090/insania.v27i2.6924.
[38] M. Bueno, F. Perez, R. Valerio, and E. M. Q. Areola, "A Usability Study on Google Site and Wordwall.net: Online Instructional Tools for Learning Basic Integration Amid Pandemic," *Journal of Global Business and Social Entrepreneurship (GBSE)*, vol. 7, no. 23, pp. 61–71, 2022. http://gbse.my/V8%20NO.23%20(JANUARY%202022)/Paper-288-.pdf
[39] John W. Creswell, *Educational research : planning, conducting, and evaluating quantitative and qualitative research*, 4th ed. Boston: Pearson, 2012.
[40] C.C. Serdar, M. Cihan, D. Yücel and M.A. Serdar, "Sample size, power and effect size revisited: simplified and practical approaches in pre-clinical, clinical and laboratory studies", Biochemia Medica, vol.31, no. 1, pp. 27-53, 2021. https://doi.org/10.11613/BM.2021.010502.
[41] Cohen L., L. Manion, and K. Morrison, *Research Methods in Education*. New York: Routledge, 2017.
[42] M. Suseno, B. Hayat, M.D.K. Putra, J.K.Bien, R. Rachmawati, and H. Hartanto, "A Differential Item Functioning (DIF) Analysis of The Mobile Phone Problem Use Scale in Indonesian Schools With and Without Smartphone Banned Policy," *Cogent Psychology*, vol. 9, no. 1, Oct. 2022, https://doi.org/10.1080/23311908.2022.2137306.
[43] M. Mailizar, A. Almanthari, S. Maulina, and S. Bruce, 'Secondary School Mathematics Teachers' Views on E-learning Implementation Barriers during the COVID-19 Pandemic: The Case of Indonesia', EURASIA J Math Sci Tech Ed, vol. 16, no. 7, p. em1860, May 2020, doi: 10.29333/ejmste/8240.
[44] S. Asgari, J. Trajkovic, M. Rahmani, W. Zhang, R. C. Lo, and A. Sciortino, "An observational study of engineering online education during the COVID-19 pandemic," *PLoS One*, vol. 16, no. 4, p. e0250041, Apr. 2021, doi: 10.1371/journal.pone.0250041.
[45] A. Selvaraj, V. Radhin, N. KA, N. Benson, and A. J. Mathew, "Effect of pandemic based online education on teaching and learning system," *Int J Educ Dev*, vol. 85, p. 102444, Sep. 2021, doi: 10.1016/j.ijedudev.2021.102444.
[46] S. Zhang, Y. Wen, and Q. Liu, "Exploring student teachers' social knowledge construction behaviors and collective agency in an online collaborative learning environment," *Interactive Learning Environments*, vol. 30, no. 3, pp. 539–551, Feb. 2022, doi: 10.1080/10494820.2019.1674880.
[47] F. Rasheed and A. Wahid, "Learning style detection in E-learning systems using machine learning techniques," *Expert Syst Appl*, vol. 174, p. 114774, Jul. 2021, doi: 10.1016/j.eswa.2021.114774.
[48] M. A. Hassan, U. Habiba, F. Majeed & M. Shoaib "Adaptive gamification in e-learning based on students' learning styles,' *Interactive Learning Environments*, 29:4, 545-565, Mar 2019, DOI: 10.1080/10494820.2019.1588745.

BIOGRAPHIES OF AUTHORS

Sri Rezeki is a Senior Associate Professor and Lecturer of Mathematics Education Department at FKIP UIR, specializing in educational media, learning resources, and statistics. Born in Tanjung Uban on January 15, 1971, she pursued her higher education in Mathematics Education at Universitas Riau (Bachelor's), Statistics at Institut Pertanian Bogor (Master's), and Mathematics at Universitas Gajah Mada (Doctoral). With a rich academic background and expertise in her field, she can be reached at email: sri_rezeki@edu.uir.ac.id

Sindi Amelia is a Lecturer of Mathematics Education Department at FKIP UIR, specializing in Curriculum and Instruction, Educational Media and Resources, Analysis, and Geometry. Born in Kerinci on November 25, 1988, she pursued her higher education in Mathematics Education at Universitas Riau (Bachelor's) and Universitas Pendidikan Indonesia (Master's). With a passion for teaching and expertise in various aspects of mathematics education, she can be contacted via email at sindiamelia88@edu.uir.ac.id.

4. Bukti konfirmasi artikel accepted (2 September 2024)

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sindi amelia <sindiamelia88@edu.uir.ac.id>

[IJERE] Editor Decision
2 messages

Dr. Lina Handayani <ijere@iaescore.com> Mon, Sep 2, 2024 at 9:26 PM
Reply-To: "Assoc. Prof. Dr. Lina Handayani" <ijere@iaescore.com>
To: Sindi Amelia <sindiamelia88@edu.uir.ac.id>
Cc: Sri Rezeki <sri_rezeki@edu.uir.ac.id>

The following message is being delivered on behalf of International Journal of Evaluation and Research in Education (IJERE).

-- Paper ID# 30051
-- Authors must strictly follow the guidelines for authors at http://iaescore.com/gfa/ijere.docx
-- Number of minimum references is 30 sources (mainly journal articles) for research paper
-- and minimum 50 sources (mainly journal articles) for review paper

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Dear Prof/Dr/Mr/Mrs: Sindi Amelia,

It is my great pleasure to inform you that your paper entitled "Enhancing Mathematics Learning in Phase E: Evaluating the Effectiveness of the Wordwall Game" is conditionally ACCEPTED and will be published on the International Journal of Evaluation and Research in Education (IJERE), a SCOPUS (https://www.scopus.com/sourceid/21100934092) and ScimagoJR (https://www.scimagojr.com/journalsearch.php?q=21100934092&tip=sid&clean=0) indexed journal. Congratulations!

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Once you have completed all the aforementioned documents, we will issue a certificate of acceptance (CoA).

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Best Regards,
Assoc. Prof. Dr. Lina Handayani
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Each accepted paper is charged USD 355 to help cover some of the publication costs. This fee covers the standard eight-page manuscript (including the list of references but excluding the authors' biographies), and any published manuscript that exceeds eight pages will incur an additional fee of USD 50 per page. For USD to IDR currency conversion, Indonesian authors should use xe.com.

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Comments to the Author

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:
Overall, the paper entitled "Enhancing Mathematics Learning in Phase E: Assessing Wordwall Effectiveness" is very good and well organized. However, this paper has shortcomings in its appearance, so this paper needs a little improvement in its appearance.

International Journal of Evaluation and Research in Education (IJERE)
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sindi amelia <sindiamelia88@edu.uir.ac.id> Tue, Sep 3, 2024 at 10:21 PM
To: "Assoc. Prof. Dr. Lina Handayani" <ijere@iaescore.com>
Cc: Sri Rezeki <sri_rezeki@edu.uir.ac.id>

Dear IJERE's Editor,

Thank you for your email. I am pleased to inform you that we have completed the payment and the Turnitin check for our paper entitled "Enhancing Mathematics Learning in Phase E: Assessing WordWall Effectiveness" The requested documents, including the final camera-ready paper, the Turnitin similarity report, and the payment evidence, are attached to this email.

We look forward to receiving the Certificate of Acceptance (CoA) soon.

Thank you for your assistance.

Best Regards,

Authors

[Quoted text hidden]

--

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5. Bukti penyerahan Certificate of Acceptance dan konfirmasi keterangan waktu publikasi (8 November 2024)

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sindi amelia <sindiamelia88@edu.uir.ac.id>

[IJERE] Formal Acceptance of Manuscript for Publication - Enhancing mathematics learning in phase E: assessing wordwall effectiveness

2 messages

editorialijere@gmail.com <editorialijere@gmail.com> Fri, Nov 8, 2024 at 7:31 AM
To: sri_rezeki@edu.uir.ac.id, sindiamelia88@edu.uir.ac.id

Dear Dr./Professor Sri Rezeki, Sindi Amelia

We are delighted to formally notify you of the acceptance of your manuscript, titled "Enhancing mathematics learning in phase E: assessing wordwall effectiveness," for publication by International Journal of Evaluation and Research in Education (IJERE).

The editorial team thoroughly reviewed your work and found it to be a valuable contribution to the field. A formal certificate of acceptance is attached to this email for your reference.

Your manuscript is currently undergoing the layout process and a final editorial review to ensure it adheres to our publication standards. We anticipate this process to be completed and your manuscript will be published for Vol 14, No 2: April 2025 issue. Following the completion of these steps, we will contact you to discuss the fine tuning and any further details.

Congratulations on this achievement! We are honored to publish your work and look forward to its successful release.

Sincerely,

Editorial Staff on behalf of Editor-in-Chief
International Journal of Evaluation and Research in Education (IJERE)
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Sri Rezeki <sri_rezeki@edu.uir.ac.id> Sat, Nov 9, 2024 at 8:04 AM
To: editorialijere@gmail.com
Cc: sindiamelia88@edu.uir.ac.id

Thank you so much for the great news!
Sincerely,

Assoc. Prof. Sri Rezeki
[Quoted text hidden]
--
Dr. Hj. Sri Rezeki, S.Pd., M.Si
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International Journal of Evaluation and Research in Education (IJERE)

CERTIFICATE OF ACCEPTANCE

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The manuscript (IJERE-30051) entitled:

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Authored by:
Sri Rezeki, Sindi Amelia

November 06, 2024

The manuscript has been accepted in IJERE (ISSN 2252-8822)

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Prof. Dr. Yeo Kee Jiar
Editor-in-Chief

6. Bukti konfirmasi permintaan revisi layout dan submit revisi layout (26 November 2024)

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[IJERE-30051] Revision for Vol.14 No.2 April 2025

2 messages

IJERE Editorial <editorialijere@gmail.com> Tue, Nov 26, 2024 at 3:43 PM
To: sri_rezeki@edu.uir.ac.id, sindiamelia88@edu.uir.ac.id

Dear author(s),

I am Niko Firman writing on behalf of the layout and editing team, under the auspices of the IJERE team. We are glad to inform you that your paper is in the layout stage for possible publication in the forthcoming issue of this journal. Your cooperation for final checking and/or updating your paper is required. Please find the attached file (including comments and/or marked parts) to take further actions. **Kindly submit/send your updated paper within 2 days by replying to this email!**

Please note that this email is only assigned for layout and editing purposes. For other communication purposes, reach us through the principal contact of the journal.

Your cooperation is highly appreciated.
Thank you and have a good day.

--
Regards,
Niko Firman
IJERE Editorial Staff
on behalf of Editor-in-Chief, International Journal of Evaluation and Research in Education
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sindi amelia <sindiamelia88@edu.uir.ac.id> Wed, Nov 27, 2024 at 7:50 AM
To: IJERE Editorial <editorialijere@gmail.com>
Cc: sri_rezeki@edu.uir.ac.id

Dear Niko Firman,

Thank you for your email and the update on our paper's layout stage. Attached is the revised version of our paper, updated based on the provided comments and marked parts. Please let us know if further revisions are needed. We look forward to the publication process.

Thank you for your assistance and support. Have a great day!

Best regards,

Sindi

[Quoted text hidden]
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Enhancing mathematics learning in Phase E: assessing Wordwall effectiveness

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ABSTRACT

The use of technology, classroom atmosphere, facilities, and learning resources can support quality learning outcomes in students. Wordwall, as a gamification tool, has been proven to be effective for elementary and junior high school students in mathematics. However, the effectiveness of Wordwall in enhancing senior high school students' cognitive abilities in mathematics learning has not been investigated. Previous studies have only shown its effectiveness in improving affective abilities. Therefore, This study endeavors to evaluate the effects of using Wordwall on the mathematics learning outcomes of senior high school students in Phase E. Through quasi-experimental research with pre- and posttest group design, 38 experimental class students and 37 control class students were selected as samples in this study. The study found a statistically significant difference (sig. 0.000<0.05) in the mean learning outcomes of students who used Wordwall compared to those who did not. Descriptively, the experimental group displayed superior average mathematics learning outcomes compared to the control group, demonstrating a moderate level of effectiveness (ES=0.57). The strong effect of Wordwall can be realized if it is used not only as an exercise tool within the classroom but also as an instrument for knowledge transformation, incorporating consideration of students' learning styles.

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1. INTRODUCTION

Science and technology discipline is currently advancing rapidly, influencing various aspects of human life, including education. Since the 1970s, technology has transformed mathematics education and will undoubtedly play a major role in shaping the future of education compared to today. Educators realize the necessity to reconsider the entire education model and redesign it to be more student-centered [1]–[5].

Mathematics profoundly influences the attainment of the sustainable development goals (SDGs). Simultaneously, these goals facilitate the exploration of real-life situations within the realm of mathematics, fostering active learning for students [6], [7]. In this context, each learning objective in a mathematics lesson is linked to something meaningful for the students, incorporating aspects of their daily lives [8], [9]. Therefore, mathematics education can genuinely prepare human resources to compete in the global era. The obtained information reveals that the teaching and learning process lacks integration with technology. Consequently, students experience demotivation due to feelings of monotony and boredom associated with book-based learning and the limited communicative role of teachers. Low motivation leads to a decline in academic achievement [10]–[13]. To improve academic performance, students must consider psychological

aspects such as learning preferences, self-efficacy, and goals for achievement [14], motivation [15], [16], interests [17], and the teaching and learning environment [18], [19].

Academic performance fundamentally encompasses skills related to knowledge, skills, attitudes, and values manifested in habits of thinking and behaving. Experiencing understanding "in action" involves integrating content knowledge and cognitive competencies with the demonstration of perspective, empathy, and self-awareness-qualities collectively termed as professional dispositions [20]. A potential remedy to enhance engagement and motivation in students involves the adoption of gamification. Gamification represents an approach that incorporates game components outside the typical gaming environment [21]–[25].

Utilizing virtual gamification platforms like Wordwall.net holds the potential to heighten students' interest in their learning processes [26]–[28]. This approach is considered highly suitable for mathematics students, fostering engagement in various learning activities [29], [30]. Wordwall, functioning as an educational technology tool, is intentionally designed to facilitate interactive learning in diverse settings. It empowers both educators and learners to create personalized interactive materials, thereby enriching individual and collaborative learning experiences. These interactive resources are applicable in various pedagogical contexts, including formative assessment and gamified learning.

The Wordwall tool offers a wide array of templates, such as quizzes, matching exercises, word searches, and crossword puzzles, all of which can be customized to meet users' specific needs. Noteworthy characteristics also encompass its accessibility, adaptability, and the potential for collaboration between student and teacher teams [31]. Wordwall is accessible via any web-enabled device, encompassing interactive whiteboards, tablets, desktop and portable computers, or smartphones. Its simplicity makes it user-friendly, facilitating easy operation for average users [32].

Several studies have developed instructional materials for mathematics using Wordwall, spanning from elementary to high school levels. While these materials have undergone valid and practical testing, not all products have been tested for effectiveness. Only a limited number of studies have investigated the effectiveness of using Wordwall in mathematics education, and these studies have been limited to elementary [33]–[35] and junior high school [30] levels.

Regarding senior high school levels, the efficacy of Wordwall instructional materials tends to measure affective abilities, such as motivation and interest [36], as well as interactions among students [37]. No research has yet explored the effectiveness of Wordwall in enhancing mathematics learning outcomes at the senior high school or Phase E level. Thus, this gap in the literature serves as the basis for conducting the present study. The current investigation addresses the following two research inquiries: i) is there an influence on the mathematics learning outcomes of Phase E students after utilizing the Wordwall game for instruction? and ii) what is the effectiveness of implementing the Wordwall game in improving the mathematics learning achievements among Phase E students in mathematics instruction?

2. METHOD

Quantitative approaches with a quasi-experimental design, as delineated in Table 1, are utilized in the methodology of this study [38]. The research was conducted from September 29, 2023, to November 10, 2023, at SMAN 4 Pekanbaru, Riau Province, Indonesia. All 11 classes of tenth-grade students at SMAN 4 Pekanbaru constituted the population for this study. The sample was randomly selected in groups to obtain two representative classes. This selection was facilitated using Wordwall to ensure the presence of the Wordwall usage atmosphere earlier.

Table 1. Pre- and posttest design

Select control group	Pretest	No treatment	Posttest
Select experimental group	Pretest	Wordwall treatment	Posttest

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The data collection instrument utilized in this research is specifically designed to evaluate the mathematics learning outcomes of students through the implementation of the Wordwall mathematical game. The Wordwall instructional tool used pertains to topics such as exponential functions and system of linear equations with two variables, which have been validated and proven practical [39]. The data collection instruments employed consist of pre- and posttest questions. The pretest questions were administered to assess students' mathematics learning outcomes before any treatment was applied to both classes, while the posttest questions were utilized to evaluate their outcomes after undergoing distinct treatments.

A testing technique was employed as the data collection method in this study. This technique was utilized to obtain data regarding the students' initial abilities before any treatment, which would be acquired through pretest sheets conducted at the beginning of the session, and after the treatment, which would be

obtained through posttest sheets conducted at the end of the session. The test results obtained were analyzed using both descriptive and inferential analyses. In the descriptive data analysis, the researcher examined the mean, standard deviation, as well as the minimum and maximum scores of students' mathematics learning outcomes. In inferential data analysis, the researcher observed the differences in students' learning outcomes using the assistance of SPSS v.25.

In addition to statistical tests, this study also employed a data analysis technique to find out the effectiveness of implementing the Wordwall game on students' mathematics learning outcomes when compared to conventional learning. This assessment will be measured using a metric known as effect size (ES). The formula and criteria for ES used are [40]:

$$ES = \frac{Mean\ of\ experimental\ group - mean\ of\ control\ group}{pooled\ standard\ deviation} \quad (1)$$

to calculate the pooled deviation, the formula should be:

$$SD_{pooled} = \sqrt{\frac{(N_E-1)SD_E^2+(N_C-1)SD_C^2}{N_E+N_C-2}} \quad (2)$$

where N_E = number in the experimental group, N_C = number in the control group, SD_E = standard deviation of the experimental group, and SD_C = standard deviation of the control group. The results of the ES calculation are interpreted as shown in Table 2.

Table 2. Criteria of ES

Criteria	Interpretation
$ES \leq 0.20$	Weak effect
$0.20 < ES \leq 0.50$	Modest effect
$0.50 < ES \leq 1.00$	Moderate effect
$ES > 1.00$	Strong effect

3. RESULTS AND DISCUSSION

3.1. Descriptive statistical analysis

The pretest and posttest data collected are analyzed descriptively to calculate the average, standard deviation, lowest value, and highest value. These statistical measures provide a comprehensive understanding of the distribution and central tendencies within the dataset. A summary of the results of the descriptive analysis of pretest and posttest data for Phase E students is presented in Table 3.

Table 3. Description of pre- and posttest data of students' mathematics learning outcomes

Descriptive statistics	Pretest		Posttest	
	Experimental group	Control group	Experimental group	Control group
N	38	37	38	37
$\bar{X}$	27.01	28.13	98.37	93.43
SD	17.81	12.82	7.76	9.55
Min	0	0	52	48
Max	63	41	100	100

According to the data presented in Table 3, it is evident descriptively that the mean mathematics learning achievements of students in both classes before the use of Wordwall in one class tend to be similar, with better data spread in the control class. The data in the experimental class (17.81) have a wider spread compared to the data in the control class (12.82). This difference arises because both classes have the same minimum value, but students who achieved the highest score were in the experimental class (63) with a significant difference of 22 points compared to the highest score in the control class.

After implementing Wordwall, there is a descriptive superiority in the mean mathematics learning achievement of students in the experimental class (98.37) compared to the control class, with an approximate 5-point difference in the average scores favoring the experimental group. The experimental class demonstrates a narrower data spread compared to the control class, as indicated by the smaller range observed in the experimental class (48) in contrast to the range observed in the control class (52). In essence, initially, both classes seemed to have the same quality. However, after the implementation of Wordwall in the experimental class, the learning outcome improved.

3.2. Inferential statistical analysis

Subsequently, to investigate the research inquiries, inferential statistical methods were applied to analyze the data. However, before conducting these statistical tests, assumption tests were performed, namely tests for normality and homogeneity of variance. The test of normality was conducted as a requirement for analysis of variance, while the variance homogeneity test was performed as a requirement for the t-test. If the data did not follow a normal distribution, a nonparametric test, specifically the Mann-Whitney test, would be employed without going through the homogeneity test series. The findings of the normality assessment for the pretest data of students in both instructional cohorts are depicted in Table 4.

The criterion used for testing is that if the p-value (Sig.) exceeds the predetermined significance level (α=0.05), then H_0 is accepted; otherwise, H_0 is rejected. The normality test employed is the Shapiro-Wilk test, as the data size exceeds 30. In the table, it is evident that the probability value (sig.) for one of the datasets is below 0.05. This implies that H_0 is rejected, leading to the conclusion that the data for both groups do not follow a normal distribution. Consequently, the equivalence test for pretest data on student's mathematics learning achievements employs a non-parametric test, specifically the Mann-Whitney test, the outcomes of which are detailed in Table 5.

The testing criterion utilized is that if the p-value (Sig.) exceeds the threshold of 0.05, then H_0 is accepted; otherwise, H_0 is rejected. In the table, it is noted that the probability value (sig.) exceeds 0.05, thus H_0 is accepted. Consequently, there exists no disparity between the pretest data concerning mathematics learning achievements within the experimental class and the control class. After statistically confirming that both classes have the same average test scores, the next step is to analyze the post-test data to determine whether Wordwall has an effect on mathematics student learning outcomes. This analysis begins with a normality test, as depicted in Table 6.

Based on Table 6, it is evident that the probability value (sig.) for one of the datasets is below 0.05. Therefore, H_0 is rejected, indicating that the data for these two groups are not normally distributed. Consequently, the comparison of posttest data concerning students' mathematics learning achievements utilizes the Mann-Whitney test. The result is presented in Table 7.

Table 4. Normality test of pretest data on students' mathematics learning outcomes

Shapiro-Wilk	Experimental class	Control class
Stat.	0.945	0.778
Df	38	37
Sig.	0.060	0.000

H_0: the sample is selected from a population exhibiting a normal distribution pattern.
H_1: the sample is selected from a population that is not exhibiting a normal distribution.

Table 5. Test of equality of pretest data of student's mathematics learning outcome

Mann-Whitney	Z	Sig. (2-tailed)	H_0
612.000	-0.965	0.335	Accepted

H_0: $\mu_1 = \mu_2$
H_1: $\mu_1 \neq \mu_2$
where: μ_1 = average pretest data for mathematics learning achievement of students using Wordwall and μ_2 = average pretest data for mathematics learning achievement of students not using Wordwall.

Table 6. Normality test of posttest data on students' mathematics learning outcomes

Shapiro-Wilk	Experiment	Control
Stat.	0.203	0.614
Df	38	37
Sig.	0.000	0.000

H_0: The sample is selected from a population exhibiting a normal distribution pattern.
H_1: The sample is selected from a population that is not exhibiting a normal distribution.

Table 7. Test of equality of posttest data of students' mathematics learning outcome

Mann-Whitney	Z	Sig. (2-tailed)	H_0
210.000	-5.480	0.000	Rejected

H_0: $\mu_1 = \mu_2$
H_1: $\mu_1 \neq \mu_2$
where: μ_1 = average posttest data for mathematics learning achievement of students using Wordwall and μ_2 = average posttest data for mathematics learning achievement of students not using Wordwall.

According to the data presented in the table, a probability value (sig.) being below 0.05 leads to rejecting the null hypothesis (H_0), suggesting a significant difference between the posttest data on mathematics learning outcomes in the experimental class and the control class. Moreover, based on descriptive data, the experimental class demonstrates superior mathematics learning outcomes compared to the control class. These findings suggest that the implemented Wordwall in the experimental class potentially contributes to enhanced mathematics learning outcomes when compared to traditional methods employed in the control class.

3.3. Effectiveness

In order to assess the efficacy of employing Wordwall on the mathematics learning outcomes of Phase E students, the computation of the ES is conducted, as outlined in Table 8. This measurement enables a more profound comprehension of the magnitude and significance of Wordwall's impact on student learning outcomes, offering valuable insights for both educators and researchers. Through the quantification of the ES, researchers can ascertain the practical significance of utilizing Wordwall as an educational tool to enhance mathematics learning outcomes within Phase E classrooms.

Based on the calculation results, the effectiveness of learning outcomes falls within the moderate criteria (0.57). The difference between this score and the strong category is quite significant. This is due to the minimal disparity between the average and data spread of the two classes. In the implementation of Wordwall usage in the classroom, grouping is carried out due to the prohibition of mobile phone use in Indonesian schools [41], [42]. Students are only permitted to use laptops, although not all students have access to these devices. Consequently, the formation of groups becomes an alternative to ensure that all students can use Wordwall collectively. Using their laptops, student groups access the provided Wordwall link to solve various types of questions, including short form, multiple choice, or matching.

However, challenges arise when there is uneven participation among students within the groups. Only a portion of students actively completes Wordwall tasks. Furthermore, some students who could easily solve exercises in the textbook face confusion when using Wordwall. Students are not yet familiar with the presentation style [43], [44]. This indicates that students within each group exhibit diverse characteristics [45] and learning styles [46]–[48], underscoring the importance of considering learning styles before the initiation of interventions. Moreover, it is advisable that Wordwall is designed not solely as an exercise tool but as a knowledge transformation instrument. The use of technology throughout the learning activities is believed to be more effective than its partial application. This strategy can enhance the effectiveness of Wordwall as an integral component of the educational process.

Table 8. ES of students' mathematics learning outcomes

N_E	38
N_C	37
SD_E	7.76
SD_C	9.55
SD_{pooled}	8.69
$\bar{x}_E$	98.37
$\bar{x}_C$	93.43
ES	0.57

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4. CONCLUSION

In conclusion, this study demonstrated a statistically significant difference (sig. 0.000<0.05) in the mean academic achievement of students who learned using Wordwall compared to those who did not. Descriptively, the experimental group exhibited higher average mathematics learning outcomes compared to the control group, with a moderate level of effectiveness (ES=0.57). The heightened effectiveness of Wordwall can be achieved by utilizing it not only as a classroom exercise tool but also as a medium for knowledge transformation, taking into account the diverse learning styles of students.

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REFERENCES

[1] J. Engelbrecht, S. Llinares, and M. C. Borba, "Transformation of the mathematics classroom with the internet," *ZDM*, vol. 52, no. 5, pp. 825–841, Oct. 2020, doi: 10.1007/s11858-020-01176-4.

[2] E. L. Karcher *et al.*, "Adapting the program redesign model for a student-centered curricula renewal in animal science," *Natural Sciences Education*, vol. 52, no. 1, p. e20105, Jun. 2023, doi: 10.1002/nse2.20105.

[3] K. N. Falbe and R. Seglem, "Teaching is messy: using lesson study to reimagine student-centered clinical experiences," *Education Sciences*, vol. 13, no. 7, p. 735, Jul. 2023, doi: 10.3390/educsci13070735.

[4] T. Avidnai and A. Palatnik, "How teachers' knowledge and didactic contract evolve when transitioning to student-centered pedagogy-the case of project-based learning," in *Twelfth Congress of the European Society for Research in Mathematics Education (CERME12)*, 2022, , pp. 1–9.

[5] I. Barilsam, E. K. Yurbelyaa, and A. Bordoh, "Teachers perspective on redesigning social studies curriculum for student-centered and constructivist learning: empirical study of secondary schools, Northern Region," *Social Education Research*, vol. 3, no. 2, pp. 307–321, Aug. 2022, doi: 10.37256/ser.3220221676.

[6] M. Lafuente-Lechuga, J. Cifuentes-Faura, and U. Faura-Martínez, "Mathematics applied to the economy and sustainable development goals: a necessary relationship of dependence," *Education Sciences*, vol. 10, no. 11, p. 339, Nov. 2020, doi: 10.3390/educsci10110339.

[7] R. AlAli, K. Alsoud, and F. Athamneh, "Towards a sustainable future: evaluating the ability of stem-based teaching in achieving sustainable development goals in learning," *Sustainability*, vol. 15, no. 16, p. 12542, Aug. 2023, doi: 10.3390/su151612542.

[8] J. Samuelsson, "Developing students' relationships with mathematics," *Educational Action Research*, vol. 31, no. 2, pp. 180–194, Mar. 2023, doi: 10.1080/09650792.2021.1889012.

[9] J. Polman, L. Hornstra, and M. Volman, "The meaning of meaningful learning in mathematics in upper-primary education," *Learning Environments Research*, vol. 24, no. 3, pp. 469–486, Oct. 2021, doi: 10.1007/s10984-020-09337-8.

[10] F. Wang *et al.*, "Neural cognitive diagnosis for intelligent education systems," in *Proceedings of the AAAI Conference on Artificial Intelligence*, pp. 6153–6161, Apr. 2020, doi: 10.1609/aaai.v34i04.6080.

[11] A. Camacho, R. A. Alves, and P. Boscolo, "Writing motivation in school: a systematic review of empirical research in the early twenty-first century," *Educational Psychology Review*, vol. 33, no. 1, pp. 213–247, Mar. 2021, doi: 10.1007/s10648-020-09530-4.

[12] Tarh, Maison, B. Syefrinando, M. Daryanto, and H. Salma, "Students' self-regulation and motivation in learning science," *International Journal of Evaluation and Research in Education (IJERE)*, vol. 9, no. 4, pp. 865–873, Dec. 2020, doi: 10.11591/ijere.v9i4.20657.

[13] R. H. Rafiola, P. Setyosari, C. L. Radjah, and M. Ramli, "The effect of learning motivation, self-efficacy, and blended learning on students' achievement in the industrial revolution 4.0," *International Journal of Emerging Technologies in Learning*, vol. 15, no. 8, pp. 73–82, 2020, doi: 10.3991/ijet.v15i08.12525.

[14] Y. Wang, L. Tian, and E. S. Huebner, "Basic psychological needs satisfaction at school, behavioral school engagement, and academic achievement: longitudinal reciprocal relations among elementary school students," *Contemporary Educational Psychology*, vol. 56, pp. 130–139, Jan. 2019, doi: 10.1016/j.cedpsych.2019.01.003.

[15] A. Alhadabi and A. C. Karpinski, "Grit, self-efficacy, achievement orientation goals, and academic performance in university students," *International Journal of Adolescence and Youth*, vol. 25, no. 1, pp. 519–535, Dec. 2020, doi: 10.1080/02673843.2019.1679202.

[16] H. Wu, S. Li, J. Zheng, and J. Guo, "Medical students' motivation and academic performance: the mediating roles of self-efficacy and learning engagement," *Medical Education Online*, vol. 25, no. 1, p. 1742964, Jan. 2020, doi: 10.1080/10872981.2020.1742964.

[17] M. Y. Mazana, C. S. Montero, and R. O. Casmir, "Investigating students' attitude towards learning mathematics," *International Electronic Journal of Mathematics Education*, vol. 14, no. 1, pp. 207–231, Dec. 2018, doi: 10.29333/iejme/3997.

[18] N. A. Abdulrahim and M. J. Orosco, "Culturally responsive mathematics teaching: a research synthesis," *The Urban Review*, vol. 52, no. 1, pp. 1–25, Mar. 2020, doi: 10.1007/s11256-019-00509-2.

[19] T. Honicke, J. Broadbent, and M. Fuller-Tyszkiewicz, "Learner self-efficacy, goal orientation, and academic achievement: exploring mediating and moderating relationships," *Higher Education Research & Development*, vol. 39, no. 4, pp. 689–703, Jun. 2020, doi: 10.1080/07294360.2019.1685941.

[20] R. Raj *et al.*, "Professional competencies in computing education," in *Proceedings of the 2021 Working Group Reports on Innovation and Technology in Computer Science Education*, Dec. 2021, pp. 133–161, doi: 10.1145/3502870.3506570.

[21] G. P. Türkmen and D. Soybaş, "The effect of gamification method on students' achievements and attitudes towards mathematics," *Bartın Üniversitesi Eğitim Fakültesi Dergisi*, vol. 8, no. 1, pp. 258–298, Feb. 2019, doi: 10.14686/buefad.424575.

[22] Q. Aini, N. Azizah, R. Salam, N. P. L. Santoso, and S. Millah, "iLearning education based on gamification blockchain," *Indonesian Journal of Electrical Engineering and Computer Science*, vol. 26, no. 1, pp. 531–538, Apr. 2022, doi: 10.11591/ijeecs.v26.i1.pp531-538.

[23] F. A. Potoma, R. M. Silitonga, and Y.-T. Jou, "Rimigs: the impact of gamification on students' motivation and performance in programming class," *Indonesian Journal of Electrical Engineering and Computer Science*, vol. 24, no. 3, pp. 1789–1795, Dec. 2021, doi: 10.11591/ijeecs.v24.i3.pp1789-1795.

[24] A. Manzano-León *et al.*, "Between level up and game over: a systematic literature review of gamification in education," *Sustainability*, vol. 13, no. 4, p. 2247, Feb. 2021, doi: 10.3390/su13042247.

[25] M. Rauscheinberger, A. Willems, M. Temeden, and J. Thomaschewski, "Towards the use of gamification frameworks in learning environments," *Journal of Interactive Learning Research*, vol. 30, no. 2, pp. 147–165, 2019.

[26] L. M. Carmona-Chica and A. L. Argudo-Garzón, "Vocabulary skills and virtual tools in students of A2 Universidad Católica de Cuenca," *Revista Arbitrada Interdisciplinaria Koinonía*, vol. 7, no. 1, pp. 23–45, Jun. 2022, doi: 10.35381/r.k.v7i1.1677.

[27] V. C. Segaran and H. Hashim, "'More online quizzes, please!' the effectiveness of online quiz tools in enhancing the learning of grammar among ESL learners," *International Journal of Academic Research in Business and Social Sciences*, vol. 12, no. 1, pp. 1756–1770, Jan. 2022, doi: 10.6007/IJARBSS/v12-i1/12064.

[28] A. Bilova, "Implementing enjoyable learning strategy with Wordwall in the EFL classroom," *English and American Studies*, no. 20, pp. 58–64, Jun. 2023, doi: 10.15421/382308.

[29] G. M. Chans and M. P. Castro, "Gamification as a strategy to increase motivation and engagement in higher education chemistry students," *Computers*, vol. 10, no. 10, p. 132, Oct. 2021, doi: 10.3390/computers10100132.

[30] T. K. Rahma *et al.*, "Using Wordwall as a gamification-based mathematics learning material to support students' learning activities," in *AIP Conference Proceedings 2023*, p. 020043, doi: 10.1063/5.0141610.

[31] H. Kurniawan, Supriyono, Tursilowati, and I. J. Kustiningsih, "Action research: CPA math word wall group competition to improve conceptual understanding in algebra problem solving activities," in *2nd International Conference on Education and Technology (ICETECH 2021). Advances in Social Science, Education and Humanities Research*, 2022, pp. 358–364, doi: 10.2991/assehr.k.220103.051.

[32] C. Rodriguez-Escobar, J. Cuevas-Lepe, and L. Maluenda-Parraguez, "Assessing the effectiveness of Wordwall.net as a vocabulary learning tool: pre-service EFL teachers' perspectives," *Journal of Education and Practice*, vol. 14, no. 31, pp. 41–51, Nov. 2023, doi: 10.7176/JEP/14-31-04.
[33] M. Palioura and C. Dimoulas, "Digital storytelling in education: a transmedia integration approach for the non-developers," *Education Sciences*, vol. 12, no. 8, p. 559, Aug. 2022, doi: 10.3390/educsci12080559.
[34] C. S. Hibaya, T. Paauwono, and T. Sotiyan, "Development of online lesson to enhance mathematics achievement for grade 3 students," in *Conference Proceedings: The 4th International Conference on Informatics, Agriculture, Management, Business Administration, Engineering, Science and Technology*, 2023, pp. 21–25.
[35] S. Sudarsono and Sopriya, "Development of web-based interactive game media application Wordwall material odd numbers even mathematics subjects grade II elementary school," *International Conference on Elementary Education*, vol. 5, no. 1, pp. 629–639, 2023.
[36] E. Shafira and A. Hikmat, "The effectiveness of evaluation of mathematics learning using Wordwall media in elementary school," *Scaffolding: Jurnal Pendidikan Islam dan Multikulturalisme*, vol. 5, no. 3, pp. 1–12, Aug. 2023, doi: 10.37680/scaffolding.v5i2.3406.
[37] K. I. Lestari, I. N. Arcana, A. E. Susetyo, and K. S. Kuncoro, "Development of online learning quiz and educational game using word walls in mathematics for grade 10," *INSANIA : Jurnal Pemikiran Alternatif Kependidikan*, vol. 27, no. 2, pp. 145–159, Dec. 2022, doi: 10.24090/insania.v27i2.6924.
[38] M. Bueno, F. Perez, R. Valerio, E. Mareth, and Q. Arcola, "A usability study on google site and Wordwall.Net: online instructional tools for learning basic integration amid pandemic," *Journal of Global Business and Social Entrepreneurship (GBSE)*, vol. 7, no. 23, pp. 61–71, 2022.
[39] J. W. Creswell, *Educational research: planning, conducting, and evaluating quantitative and qualitative research*, 4th ed. Boston: Pearson, 2012.
[40] C. C. Serdar, M. Cihan, D. Yücel, and M. A. Serdar, "Sample size, power and effect size revisited: simplified and practical approaches in pre-clinical, clinical and laboratory studies," *Biochemia medica*, vol. 31, no. 1, pp. 27–53, Feb. 2021, doi: 10.11613/BM.2021.010502.
[41] L. Cohen, L. Manion, and K. Morrison, *Research methods in education*. New York: Routledge, 2017.
[42] M. Suseno, B. Hayat, M. D. K. Putra, J. K. Bien, R. Rachmawati, and H. Hartanto, "A differential item functioning (DIF) analysis of the mobile phone problem use scale in Indonesian schools with and without smartphone banned policy," *Cogent Psychology*, vol. 9, no. 1, p. 2137506, Dec. 2022, doi: 10.1080/23311908.2022.2137506.
[43] M. Mailizar, A. Almanthari, S. Maulina, and S. Bruce, "Secondary school mathematics teachers' views on e-learning implementation barriers during the COVID-19 pandemic: the case of Indonesia," *Eurasia Journal of Mathematics, Science and Technology Education*, vol. 16, no. 7, p. em1860, May 2020, doi: 10.29333/ejmste/8240.
[44] S. Asgari, J. Trajkovic, M. Rahmani, W. Zhang, R. C. Lo, and A. Sciortino, "An observational study of engineering online education during the COVID-19 pandemic," *PLOS ONE*, vol. 16, no. 4, p. e0250041, Apr. 2021, doi: 10.1371/journal.pone.0250041.
[45] A. Selvaraj, V. Radhin, N. KA, N. Benson, and A. J. Mathew, "Effect of pandemic based online education on teaching and learning system," *International Journal of Educational Development*, vol. 85, p. 102444, Sep. 2021, doi: 10.1016/j.ijedudev.2021.102444.
[46] S. Zhang, Y. Wen, and Q. Liu, "Exploring student teachers' social knowledge construction behaviors and collective agency in an online collaborative learning environment," *Interactive Learning Environments*, vol. 30, no. 3, pp. 539–551, Feb. 2022, doi: 10.1080/10494820.2019.1674880.
[47] F. Rasheed and A. Wahid, "Learning style detection in e-learning systems using machine learning techniques," *Expert Systems with Applications*, vol. 174, p. 114774, Jul. 2021, doi: 10.1016/j.eswa.2021.114774.
[48] M. A. Hassan, U. Habiba, F. Majeed, and M. Shoaib, "Adaptive gamification in e-learning based on students' learning styles," *Interactive Learning Environments*, vol. 29, no. 4, pp. 545–565, May 2021, doi: 10.1080/10494820.2019.1588745.

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Enhancing Mathematics Learning in Phase E: Assessing Wordwall Effectiveness

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ABSTRACT

The use of technology, classroom atmosphere, facilities, and learning resources can support quality learning outcomes in students. Wordwall, as a gamification tool, has been proven to be effective for elementary and junior high school students in mathematics. However, the effectiveness of Wordwall in enhancing senior high school students' cognitive abilities in mathematics learning has not been investigated. Previous studies have only shown its effectiveness in improving affective abilities. Therefore, This study endeavors to evaluate the effects of using Wordwall on the mathematics learning outcomes of senior high school students in Phase E. Through quasi-experimental research with pre- and posttest group design, 38 experimental class students and 37 control class students were selected as samples in this study. The study found a statistically significant difference (sig. 0.000<0.05) in the mean learning outcomes of students who used Wordwall compared to those who did not. Descriptively, The experimental group displayed superior average mathematics learning outcomes compared to the control group, demonstrating a moderate level of effectiveness (ES=0.57). The strong effect of Wordwall can be realized if it is used not only as an exercise tool within the classroom but also as an instrument for knowledge transformation, incorporating consideration of students' learning styles.

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1. INTRODUCTION

Science and technology discipline is currently advancing rapidly, influencing various aspects of human life, including education. Since the 1970s, technology has transformed mathematics education and will undoubtedly play a major role in shaping the future of education compared to today. Educators realize the necessity to reconsider the entire education model and redesign it to be more student-centered [1] - [5].

Mathematics profoundly influences the attainment of the Sustainable Development Goals (SDGs). Simultaneously, these goals facilitate the exploration of real-life situations within the realm of mathematics, fostering active learning for students [6], [7]. In this context, each learning objective in a mathematics lesson is linked to something meaningful for the students, incorporating aspects of their daily lives [8], [9]. Therefore, mathematics education can genuinely prepare human resources to compete in the global era.

The obtained information reveals that the teaching and learning process lacks integration with technology. Consequently, students experience demotivation due to feelings of monotony and boredom associated with book-based learning and the limited communicative role of teachers. Low motivation leads to a decline in academic achievement [10] - [13]. To improve academic performance, students must consider

Psychological aspects such as learning preferences, self-efficacy, and goals for achievement [14], motivation [15], [16], interests [17], and the teaching and learning environment [18], [19].

Academic performance fundamentally encompasses skills related to knowledge, skills, attitudes, and values manifested in habits of thinking and behaving. Experiencing understanding "in action" involves integrating content knowledge and cognitive competencies with the demonstration of perspective, empathy, and self-awareness—qualities collectively termed as professional dispositions [20]. A potential remedy to enhance engagement and motivation in students involves the adoption of gamification. Gamification represents an approach that incorporates game components outside the typical gaming environment [21] - [25].

Utilizing virtual gamification platforms like Wordwall.net holds the potential to heighten students' interest in their learning processes [26] - [28]. This approach is considered highly suitable for mathematics students, fostering engagement in various learning activities [29], [30]. Wordwall, functioning as an educational technology tool, is intentionally designed to facilitate interactive learning in diverse settings. It empowers both educators and learners to create personalized interactive materials, thereby enriching individual and collaborative learning experiences. These interactive resources are applicable in various pedagogical contexts, including formative assessment and gamified learning.

The Wordwall tool offers a wide array of templates, such as quizzes, matching exercises, word searches, and crossword puzzles, all of which can be customized to meet users' specific needs. Noteworthy characteristics also encompass its accessibility, adaptability, and the potential for collaboration between student and teacher teams [31]. Wordwall is accessible via any web-enabled device, encompassing interactive whiteboards, tablets, desktop and portable computers, or smartphones. Its simplicity makes it user-friendly, facilitating easy operation for average users [32].

Several studies have developed instructional materials for mathematics using Wordwall, spanning from elementary to high school levels. While these materials have undergone valid and practical testing, not all products have been tested for effectiveness. Only a limited number of studies have investigated the effectiveness of using Wordwall in mathematics education, and these studies have been limited to elementary [33] - [35] and junior high school [30] levels.

Regarding senior high school levels, the efficacy of Wordwall instructional materials tends to measure affective abilities, such as motivation and interest [36], as well as interactions among students [37]. No research has yet explored the effectiveness of Wordwall in enhancing mathematics learning outcomes at the senior high school or Phase E level. Thus, this gap in the literature serves as the basis for conducting the present study. The current investigation addresses the following two research inquiries: 1) Is there an influence on the mathematics learning outcomes of Phase E students after utilizing the Wordwall game for instruction? 2) What is the effectiveness of implementing the Wordwall game in improving the mathematics learning achievements among Phase E students in mathematics instruction?

2. METHOD

Quantitative approaches with a quasi-experimental design, as delineated in Table 1, are utilized in the methodology of this study [38]. The research was conducted from September 29, 2023, to November 10, 2023, at SMAN 4 Pekanbaru, Riau Province, Indonesia. All 11 classes of tenth-grade students at SMAN 4 Pekanbaru constituted the population for this study. The sample was randomly selected in groups to obtain two representative classes. This selection was facilitated using Wordwall to ensure the presence of the Wordwall usage atmosphere earlier.

Table 1. Pre- and Posttest Design

Group	Initial Assessment	Treatment	Final Assessment
Select Control Group	Pretest	No Treatment	Posttest
Select Experimental Group	Pretest	Wordwall Treatment	Posttest

The data collection instrument utilized in this research is specifically designed to evaluate the mathematics learning outcomes of students through the implementation of the Wordwall mathematical game. The Wordwall instructional tool used pertains to topics such as exponential functions and system of linear equations with two variables, which have been validated and proven practical [39]. The data collection instruments employed consist of pre- and posttest questions. The Pretest questions were administered to assess students' mathematics learning outcomes before any treatment was applied to both classes, while the posttest questions were utilized to evaluate their outcomes after undergoing distinct treatments.

A testing technique was employed as the data collection method in this study. This technique was utilized to obtain data regarding the students' initial abilities before any treatment, which would be acquired

through pretest sheets conducted at the beginning of the session, and after the treatment, which would be obtained through posttest sheets conducted at the end of the session. The test results obtained were analyzed using both descriptive and inferential analyses. In the descriptive data analysis, the researcher examined the mean, standard deviation, as well as the minimum and maximum scores of students' mathematics learning outcomes. In inferential data analysis, the researcher observed the differences in students' learning outcomes using the assistance of SPSS v.25.

In addition to statistical tests, this study also employed a data analysis technique to find out the effectiveness of implementing the Wordwall Game on students' mathematics learning outcomes when compared to conventional learning. This assessment will be measured using a metric known as Effect Size. The formula and criteria for Effect Size (ES) used are as follows [40]:

$$ES = \frac{Mean\ of\ experimental\ group - mean\ of\ control\ group}{pooled\ standard\ deviation} \quad (1)$$

To calculate the pooled deviation, the formula should be:

$$SD_{pooled} = \sqrt{\frac{(N_E-1)SD_E{}^2+(N_C-1)SD_C{}^2}{N_E+N_C-2}} \quad (2)$$

Where N_E = number in the experimental group, N_C = number in the control group, SD_E = standard deviation of the experimental group, and SD_C = standard deviation of the control group. The results of the effect size (ES) calculation are interpreted as shown in Table 2.

Table 2. Criteria of Effect Size

Criteria	Interpretation
$ES \leq 0.20$	Weak Effect
$0.20 < ES \leq 0.50$	Modest Effect
$0.50 < ES \leq 1.00$	Moderate Effect
$ES > 1.00$	Strong Effect

3. RESULTS AND DISCUSSION

3.1. Descriptive Statistical Analysis

The pretest and posttest data collected are analyzed descriptively to calculate the average, standard deviation, lowest value, and highest value. These statistical measures provide a comprehensive understanding of the distribution and central tendencies within the dataset. A summary of the results of the descriptive analysis of pretest and posttest data for Phase E students is presented in Table 3.

Table 3. Description of Pre- and Posttest Data of Students' Mathematics Learning Outcomes

Descriptive Statistics	Pretest		Posttest	
	Experimental Group	Control Group	Experimental Group	Control Group
N	38	37	38	37
$\bar{X}$	27.01	28.13	98.37	93.43
SD	17.81	12.82	7.76	9.55
Min	0	0	52	48
Max	63	41	100	100

According to the data presented in Table 3, it is evident descriptively that the mean mathematics learning achievements of students in both classes before the use of Wordwall in one class tend to be similar, with better data spread in the control class. The data in the experimental class (17.81) have a wider spread compared to the data in the control class (12.82). This difference arises because both classes have the same minimum value, but students who achieved the highest score were in the experimental class (63) with a significant difference of 22 points compared to the highest score in the control class.

After implementing Wordwall, there is a descriptive superiority in the mean mathematics learning achievement of students in the experimental class (98.37) compared to the control class, with an approximate 5-point difference in the average scores favoring the experimental group. The experimental class demonstrates a narrower data spread compared to the control class, as indicated by the smaller range observed in the experimental class (48) in contrast to the range observed in the control class (52). In essence, initially, both classes seemed to have the same quality. However, after the implementation of Wordwall in the experimental class, the learning outcome improved.

3.2. Inferential Statistical Analysis

Subsequently, to investigate the research inquiries, inferential statistical methods were applied to analyze the data. However, before conducting these statistical tests, assumption tests were performed, namely tests for normality and homogeneity of variance. The test of normality was conducted as a requirement for analysis of variance, while the variance homogeneity test was performed as a requirement for the t-test. If the data did not follow a normal distribution, a nonparametric test, specifically the Mann-Whitney test, would be employed without going through the homogeneity test series. The findings of the normality assessment for the pretest data of students in both instructional cohorts are depicted in Table 4.

Table 4. Normality Test of Pretest Data on Students' Mathematics Learning Outcomes

Shapiro-Wilk	Experimental Class	Control Class
Stat.	0.945	0.778
Df	38	37
Sig.	0.060	0.000

H_0: The sample is selected from a population exhibiting a normal distribution pattern.
H_1: The sample is selected from a population that is not exhibiting a normal distribution

The criterion used for testing is that if the p-value (Sig.) exceeds the predetermined significance level ($\propto = 0.05$), then H_0 is accepted; otherwise, H_0 is rejected. The normality test employed is the Shapiro-Wilk test, as the data size exceeds 30. In the table, it is evident that the probability value (sig.) for one of the datasets is below 0.05. This implies that H_0 is rejected, leading to the conclusion that the data for both groups do not follow a normal distribution. Consequently, the equivalence test for pretest data on student's mathematics learning achievements employs a non-parametric test, specifically the Mann-Whitney test, the outcomes of which are detailed in Table 5.

Table 5. Test of Equality of Pretest Data of Student's Mathematics Learning Outcome

Mann-Whitney	Z	Sig. (2-tailed)	H_0
612.000	-0.965	0.335	Accepted

$H_0: \mu_1 = \mu_2$
$H_1: \mu_1 \neq \mu_2$
where: μ_1 = average pretest data for mathematics learning achievement of students using Wordwall and μ_2 = average pretest data for mathematics learning achievement of students not using Wordwall.

The testing criterion utilized is that if the p-value (Sig.) exceeds the threshold of 0.05, then H_0 is accepted; otherwise, H_0 is rejected. In the table, it is noted that the probability value (sig.) exceeds 0.05, thus H_0 is accepted. Consequently, there exists no disparity between the pretest data concerning mathematics learning achievements within the experimental class and the control class. After statistically confirming that both classes have the same average test scores, the next step is to analyze the post-test data to determine whether Wordwall has an effect on mathematics student learning outcomes. This analysis begins with a normality test, as depicted in Table 6.

Table 6. Normality Test of Posttest Data on Students' Mathematics Learning Outcomes

Shapiro-Wilk	Eksperimen	Kontrol
Stat.	0.203	0.614
Df	38	37
Sig.	0.000	0.000

H_0: The sample is selected from a population exhibiting a normal distribution pattern.
H_1: The sample is selected from a population that is not exhibiting a normal distribution.

Based on Table 6, it is evident that the probability value (sig.) for one of the datasets is below 0.05. Therefore, H_0 is rejected, indicating that the data for these two groups are not normally distributed. Consequently, the comparison of posttest data concerning students' mathematics learning achievements utilizes the Mann-Whitney test. The result is presented in Table 7.

Table 7. Test of Equality of Posttest Data of Students' Mathematics Learning Outcome

Mann-Whitney	Z	Sig. (2-tailed)	H_0
210.000	-5.480	0.000	Rejected

$H_0: \mu_1 = \mu_2$
$H_1: \mu_1 \neq \mu_2$
where: μ_1 = average posttest data for mathematics learning achievement of students using Wordwall and μ_2 = average posttest data for mathematics learning achievement of students not using Wordwall.

According to the data presented in the table, a probability value (sig.) being below 0.05 leads to rejecting the null hypothesis (H_0), suggesting a significant difference between the posttest data on mathematics learning outcomes in the experimental class and the control class. Moreover, based on descriptive data, the experimental class demonstrates superior mathematics learning outcomes compared to the control class. These findings suggest that the implemented Wordwall in the experimental class potentially contributes to enhanced mathematics learning outcomes when compared to traditional methods employed in the control class.

3.3. Effectiveness

In order to assess the efficacy of employing Wordwall on the mathematics learning outcomes of Phase E students, the computation of the effect size is conducted, as outlined in Table 8. This measurement enables a more profound comprehension of the magnitude and significance of Wordwall's impact on student learning outcomes, offering valuable insights for both educators and researchers. Through the quantification of the effect size, researchers can ascertain the practical significance of utilizing Wordwall as an educational tool to enhance mathematics learning outcomes within Phase E classrooms.

Table 8. Effect Size of Students' Mathematics Learning Outcomes

Parameter	Value
N_E	38
N_C	37
SD_E	7.76
SD_C	9.55
SD_{pooled}	8.69
$\bar{x}_E$	98.37
$\bar{x}_C$	93.43
ES	0.57

Based on the calculation results, the effectiveness of learning outcomes falls within the moderate criteria (0.57). The difference between this score and the strong category is quite significant. This is due to the minimal disparity between the average and data spread of the two classes.

In the implementation of Wordwall usage in the classroom, grouping is carried out due to the prohibition of mobile phone use in Indonesian schools [41], [42]. Students are only permitted to use laptops, although not all students have access to these devices. Consequently, the formation of groups becomes an alternative to ensure that all students can use Wordwall collectively. Using their laptops, student groups access the provided Wordwall link to solve various types of questions, including short form, multiple choice, or matching.

However, challenges arise when there is uneven participation among students within the groups. Only a portion of students actively completes Wordwall tasks. Furthermore, some students who could easily solve exercises in the textbook face confusion when using Wordwall. Students are not yet familiar with the presentation style [43], [44]. This indicates that students within each group exhibit diverse characteristics [45] and learning styles [46] - [48], underscoring the importance of considering learning styles before the initiation of interventions.

Moreover, it is advisable that Wordwall is designed not solely as an exercise tool but as a knowledge transformation instrument. The use of technology throughout the learning activities is believed to be more effective than its partial application. This strategy can enhance the effectiveness of Wordwall as an integral component of the educational process.

4. CONCLUSION

In conclusion, this study demonstrated a statistically significant difference (sig. 0.000 < 0.05) in the mean academic achievement of students who learned using Wordwall compared to those who did not. Descriptively, the experimental group exhibited higher average mathematics learning outcomes compared to the control group, with a moderate level of effectiveness (ES = 0.57). The heightened effectiveness of Wordwall can be achieved by utilizing it not only as a classroom exercise tool but also as a medium for knowledge transformation, taking into account the diverse learning styles of students.

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REFERENCES

[1] J. Engelbrecht, S. Llinares, and M. C. Borba, "Transformation of the mathematics classroom with the internet," *ZDM*, vol. 52, no. 5, pp. 825–841, Oct. 2020, doi: 10.1007/s11858-020-01176-4.

[2] Karcher, E. L., Wardwell,B., Ragland, E., York, A., Machaty, Z., Stewart, K.,Radcliffe, S., & Lott, E. A. (2023). Adapting theprogram redesign model for a student-centeredcurricula renewal in animal science.Natural SciencesEducation,52,e20105.https://doi.org/10.1002/nse2.20105

[3] Falbe, K.N.; Seglem, R. Teaching Is Messy: Using Lesson Study to Reimagine Student-Centered Clinical Experiences. Educ. Sci. 2023, 13, 735. https://doi.org/10.3390/educsci13070735

[4] Tuval Avishai, Alik Palatnik. How teachers' knowledge and didactic contract evolve when transitioning to student-centered pedagogy - the case of project-based learning. Twelfth Congress of the European Society for Research in Mathematics Education (CERME12), Feb 2022, Bozen-Bolzano, Italy. hal-03748713.

[5] Iddrisu Bariham, Evelyn Kuusozume Yirbekyaa, & Anthony Bordoh. (2022). Teachers Perspective on Redesigning Social Studies Curriculum for Student-Centered and Constructivist Learning: Empirical Study of Secondary Schools, Northern Region. Social Education Research, 3(2), 307–321. https://doi.org/10.37256/ser.3220221676

[6] M. Lafuente-Lechuga, J. Cifuentes-Faura, and Ú. Faura-Martínez, "Mathematics Applied to the Economy and Sustainable Development Goals: A Necessary Relationship of Dependence," *Educ Sci (Basel)*, vol. 10, no. 11, p. 339, Nov. 2020, doi: 10.3390/educsci10110339.

[7] AlAli, R.; Alsoud, K.; Athamneh, F. Towards a Sustainable Future: Evaluating the Ability of STEM-Based Teaching in Achieving Sustainable Development Goals in Learning. Sustainability 2023, 15, 12542. https://doi.org/10.3390/su151612542

[8] J. Samuelsson, "Developing students' relationships with mathematics," *Educ Action Res*, vol. 31, no. 2, pp. 180–194, Mar. 2023, doi: 10.1080/09650792.2021.1899012.

[9] Polman, J., Hornstra, L. & Volman, M. The meaning of meaningful learning in mathematics in upper-primary education. Learning Environ Res 24, 469–486 (2021). https://doi.org/10.1007/s10984-020-09337-8

[10] F. Wang *et al.*, "Neural Cognitive Diagnosis for Intelligent Education Systems," *Proceedings of the AAAI Conference on Artificial Intelligence*, vol. 34, no. 04, pp. 6153–6161, Apr. 2020, doi: 10.1609/aaai.v34i04.6080.

[11] Camacho, A., Alves, R.A. & Boscolo, P. Writing Motivation in School: a Systematic Review of Empirical Research in the Early Twenty-First Century. Educ Psychol Rev 33, 213–247 (2021). https://doi.org/10.1007/s10648-020-09530-4

[12] T. Tanti, M. Maison, B. Syefrinando, M. Daryanto, and H. Salma, 'Students' self-regulation and motivation in learning science', Int. J. Eval. Res. Educ. IJERE, vol. 9, no. 4, p. 865, Dec. 2020, doi: 10.11591/ijere.v9i4.20657

[13] Rafiola, R., Setyosari, P., Radjah, C. & Ramli, M. (2020). The Effect of Learning Motivation, Self-Efficacy, and Blended Learning on Students' Achievement in The Industrial Revolution 4.0. International Journal of Emerging Technologies in Learning (iJET), 15(8), 71-82. Kassel, Germany: International Journal of Emerging Technology in Learning. Retrieved February 1, 2024 from https://www.learntechlib.org/p/217073/.

[14] Y. Wang, L. Tian, and E. Scott Huebner, 'Basic psychological needs satisfaction at school, behavioral school engagement, and academic achievement: Longitudinal reciprocal relations among elementary school students', Contemporary Educational Psychology, vol. 56, pp. 130–139, Jan. 2019, doi: 10.1016/j.cedpsych.2019.01.003.

[15] Amal Alhadabi & Aryn C. Karpinski (2020) Grit, self-efficacy, achievement orientation goals, and academic performance in University students, International Journal of Adolescence and Youth, 25:1, 519-535, DOI: 10.1080/02673843.2019.1679202

[16] Hongbin Wu, Shan Li, Juan Zheng & Jianru Guo (2020) Medical students' motivation and academic performance: the mediating roles of self-efficacy and learning engagement, Medical Education Online, 25:1, DOI: 10.1080/10872981.2020.1742964

[17] Mazana, Yahya Mzomwe. Suero Montero, Calkin. Olifage, Casmir Respickius. (2019). Investigating Students' Attitude towards Learning Mathematics. International Electronic Journal of Mathematics Education, 14 (1) , 207-231. 10.29333/iejme/3997.

[18] N. A. Abdulrahim and M. J. Orosco, 'Culturally Responsive Mathematics Teaching: A Research Synthesis', Urban Rev, vol. 52, no. 1, pp. 1–25, Mar. 2020, doi: 10.1007/s11256-019-00509-2.

[19] Toni Honicke, Jaclyn Broadbent & Matthew Fuller-Tyszkiewicz (2020) Learner self-efficacy, goal orientation, and academic achievement: exploring mediating and moderating relationships, Higher Education Research & Development, 39:4, 689-703, DOI: 10.1080/07294360.2019.1685941

[20] R. Raj *et al.*, "Professional Competencies in Computing Education," in *Proceedings of the 2021 Working Group Reports on Innovation and Technology in Computer Science Education*, New York, NY, USA: ACM, Dec. 2021, pp. 133–161. doi: 10.1145/3502870.3506570.

[21] G. P. TÜRKMEN and D. SOYBAŞ, "The Effect Of Gamification Method On Students' Achievements and Attitudes Towards Mathematics," *Bartın Üniversitesi Eğitim Fakültesi Dergisi*, vol. 8, no. 1, pp. 258–298, Feb. 2019, doi: 10.14686/buefad.424575.

[22] Q. Aini, N. Azizah, R. Salam, N. P. L. Santoso, and S. Millah, 'iLearning education based on gamification blockchain', Indones. J. Electr. Eng. Comput. Sci., vol. 26, no. 1, p. 531, Apr. 2022, doi: 10.11591/ijeecs.v26.i1.pp531-538.

[23] F. A. Pratama, R. M. Silitonga, and Y.-T. Jou, 'Rimigs: the impact of gamification on students' motivation and performance in programming class', Indones. J. Electr. Eng. Comput. Sci., vol. 24, no. 3, p. 1789, Dec. 2021, doi: 10.11591/ijeecs.v24.i3.pp1789-1795.

[24] A. Manzano-León *et al.*, "Between Level Up and Game Over: A Systematic Literature Review of Gamification in Education," *Sustainability*, vol. 13, no. 4, p. 2247, Feb. 2021, doi: 10.3390/su13042247.

[25] Rauschenberger, M., Willems, A., Ternieden, M. & Thomaschewski, J. (2019). Towards the use of gamification frameworks in learning environments. Journal of Interactive Learning Research, 30(2), 147-165. Waynesville, NC: Association for the Advancement of Computing in Education (AACE). Retrieved August 18, 2024 from https://www.learntechlib.org/primary/p/181283/.

[26] L. M. Carmona-Chica and A. L. Argudo-Garzón, "Vocabulary skills and virtual tools in students of A2 Universidad Católica de Cuenca," *Revista Arbitrada Interdisciplinaria Koinonía*, vol. 7, no. 1, p. 23, Jun. 2022, doi: 10.35381/r.k.v7i1.1677.

[27] Chandra Segaran, V., & Hashim, H. (2022). 'More Online Quizzes, Please!' The Effectiveness of Online Quiz Tools in Enhancing the Learning of Grammar among ESL Learners. International Journal of Academic Research in Business and Social Sciences. DOI:10.6007/ijarbss/v12-i1/12064.

[28] A. Bilova, "IMPLEMENTING ENJOYABLE LEARNING STRATEGY WITH WORDWALL IN THE EFL CLASSROOM", Anglistics and Americanistics, vol. 1, no. 20, pp. 58-64, Jun. 2023. https://doi.org/https://doi.org/10.15421/382308

[29] Chans GM, Portuguez Castro M. Gamification as a Strategy to Increase Motivation and Engagement in Higher Education Chemistry Students. Computers. 2021; 10(10):132. https://doi.org/10.3390/computers10100132
[30] T. K. Rahma *et al.*, "Using wordwall as a gamification-based mathematics learning material to support students' learning activities," 2023, p. 020043. doi: 10.1063/5.0141610
[31] Kurnawan, H, Supriyono, Tursilowati, & Kustiningsih, I. J. (2021). Action Research: CPA Math Word Wall Group Competition to Improve Conceptual Understanding in Algebra Problem Solving Activities. 2nd International Conference on Education and Technology (ICETECH 2021): Advances in Social Science, Education and Humanities Research. Atlantis Press. 10.2991/assehr.k.220103.051
[32] C. Rodrigues-Escobar, J. Cuevas-Lepe, and L. Maluenda-Parragues, "Assessing the Effectiveness of Wordwall.net as a Vocabulary Learning Tool: Pre-Service EFL Teachers' Perspectives," *Journal of Education and Practice*, vol. 14, no. 31, 2023. DOI: 10.7176/JEP/14-31-04
[33] M. Pahoura and C. Dimoulas, "Digital Storytelling in Education: A Transmedia Integration Approach for the Non-Developers," *Educ Sci (Basel)*, vol. 12, no. 8, p. 559, Aug. 2022, doi: 10.3390/educsci12080559.
[34] C. S. Hibaya, T. Pasawano, and T. Sottiwan, *Development of Online Lesson to Enhance Mathematics Achievement for Grade 3 Students*, vol. 4. Thailand: King Mongkut's Instituteof Technology Ladkrabang Princeof Chumphon Campus, 2023.
[35] S. Sudarsono and Sapriya, "Development Of Web-Based Interactive Game Media Application Wordwall Material Odd Numbers Even Mathematics Subjects Grade Ii Elementary School," *Proceeding The 5th International Conference On Elementary Education*, vol. 5, no. 1, pp. 629–639, 2023.
[36] E. Shafwa and A. Hikmat, "The Effectiveness of Evaluation of Mathematics Learning Using Wordwall Media in Elementary School," *Scaffolding: Jurnal Pendidikan Islam dan Multikulturalisme*, vol. 5, no. 3, pp. 1–12, Aug. 2023, doi: 10.37680/scaffolding.v5i2.3406.
[37] K. I. Lestari, I. N. Arcana, A. E. Susetyo, and K. S. Kuncoro, "Development of Online Learning Quiz and Educational Game Using Word Walls in Mathematics for Grade 10," *INSANIA : Jurnal Pemikiran Alternatif Kependidikan*, vol. 27, no. 2, pp. 145–159, Dec. 2022, doi: 10.24090/insania.v27i2.6924.
[38] M. Bueno, F. Perez, R. Valerio, and E. M. Q. Areola, "A Usability Study on Google Site and Wordwall.net: Online Instructional Tools for Learning Basic Integration Amid Pandemic," *Journal of Global Business and Social Entrepreneurship (GBSE)*, vol. 7, no. 23, pp. 61–71, 2022. http://gbse.my/V8%20NO.23%20(JANUARY%202022)/Paper-288-.pdf
[39] John W. Creswell, *Educational research : planning, conducting, and evaluating quantitative and qualitative research*, 4th ed. Boston: Pearson, 2012.
[40] C.C. Serdar, M. Cihan, D. Yücel and M.A. Serdar, "Sample size, power and effect size revisited: simplified and practical approaches in pre-clinical, clinical and laboratory studies", Biochemia Medica, vol.31, no. 1, pp. 27-53, 2021. https://doi.org/10.11613/BM.2021.010502.
[41] Cohen L., L. Manion, and K. Morrison, *Research Methods in Education*. New York: Routledge, 2017.
[42] M. Suseno, B. Hayat, M.D.K. Putra, J.K. Bien, R. Rachmawati, and H. Hartanto, "A Differential Item Functioning (DIF) Analysis of The Mobile Phone Problem Use Scale in Indonesian Schools With and Without Smartphone Banned Policy," *Cogent Psychology*, vol. 9, no. 1, Oct. 2022, https://doi.org/10.1080/23311908.2022.2137306.
[43] M. Mailizar, A. Almanthari, S. Maulina, and S. Bruce, 'Secondary School Mathematics Teachers' Views on E-learning Implementation Barriers during the COVID-19 Pandemic: The Case of Indonesia', EURASIA J Math Sci Tech Ed, vol. 16, no. 7, p. em1860, May 2020, doi: 10.29333/ejmste/8240.
[44] S. Asgari, J. Trajkovic, M. Rahmani, W. Zhang, R. C. Lo, and A. Sciortino, "An observational study of engineering online education during the COVID-19 pandemic," *PLoS One*, vol. 16, no. 4, p. e0250041, Apr. 2021, doi: 10.1371/journal.pone.0250041.
[45] A. Selvaraj, V. Radhin, N. KA, N. Benson, and A. J. Mathew, "Effect of pandemic based online education on teaching and learning system," *Int J Educ Dev*, vol. 85, p. 102444, Sep. 2021, doi: 10.1016/j.ijedudev.2021.102444.
[46] S. Zhang, Y. Wen, and Q. Liu, "Exploring student teachers' social knowledge construction behaviors and collective agency in an online collaborative learning environment," *Interactive Learning Environments*, vol. 30, no. 3, pp. 539–551, Feb. 2022, doi: 10.1080/10494820.2019.1674880.
[47] F. Rasheed and A. Wahid, "Learning style detection in E-learning systems using machine learning techniques," *Expert Syst Appl*, vol. 174, p. 114774, Jul. 2021, doi: 10.1016/j.eswa.2021.114774.
[48] M. A. Hassan, U. Habiba, F. Majeed & M. Shoaib "Adaptive gamification in e-learning based on students' learning styles,' *Interactive Learning Environments*, 29:4, 545-565, Mar 2019, DOI: 10.1080/10494820.2019.1588745.

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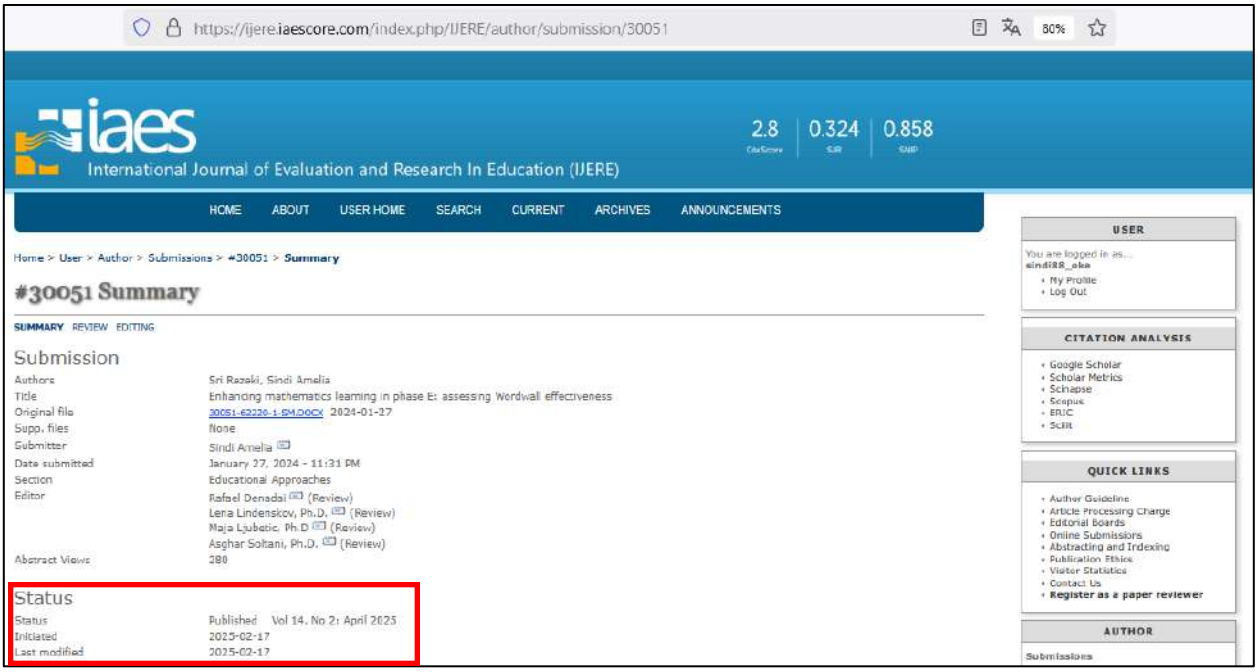

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Enhancing mathematics learning in phase E: assessing Wordwall effectiveness

Sri Rezeki, Sindi Amelia

Abstract

The use of technology, classroom atmosphere, facilities, and learning resources can support quality learning outcomes in students. Wordwall, as a gamification tool, has been proven to be effective for elementary and junior high school students in mathematics. However, the effectiveness of Wordwall in enhancing senior high school students' cognitive abilities in mathematics learning has not been investigated. Previous studies have only shown its effectiveness in improving affective abilities. Therefore, this study endeavors to evaluate the effects of using Wordwall on the mathematics learning outcomes of senior high school students in phase E. Through quasi-experimental research with pre- and post-test group design, 38 experimental class students and 37 control class students were selected as samples in this study. The study found a statistically significant difference (sig. 0.000<0.05) in the mean learning outcomes of students who used Wordwall compared to those who did not. Descriptively, the experimental group displayed superior average mathematics learning outcomes compared to the control group, demonstrating a moderate level of effectiveness (ES=0.57). The strong effect of Wordwall can be realized if it is used not only as an exercise tool within the classroom but also as an instrument for knowledge transformation, incorporating consideration of students' learning styles.

Keywords

Effectiveness; Gamification; Mathematics learning; Phase E; Wordwall

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