

The Effect of Wordwall-Assisted Gamification on Fourth-Grade Students' Mathematical Literacy

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ABSTRACT

This study examined changes in the mathematical literacy of fourth grade elementary school students following the implementation of Wordwall assisted gamification. A quantitative approach with a pre experimental one group pretest posttest design was employed. The participants were 23 fourth grade students at Srikenca Elementary School, selected through saturated sampling. Data were collected using tests and analyzed with descriptive statistics, the Shapiro Wilk normality test, and a paired samples t test using SPSS version 27. The mean score increased from 40.96 before the intervention to 82.39 afterward, representing a difference of 41.43 points. The paired samples t test indicated a statistically significant difference between pretest and posttest scores ($p < .001$). These findings suggest that Wordwall assisted gamification may support mathematical literacy learning. However, because the study involved one class without a control group, the improvement cannot be attributed exclusively to the intervention. Further research with larger samples and comparative designs is needed.

Penelitian ini bertujuan mengkaji perubahan kemampuan literasi matematis siswa kelas IV sekolah dasar setelah penerapan gamifikasi berbantuan Wordwall. Penelitian menggunakan pendekatan kuantitatif dengan desain praeksperimental satu kelompok melalui pengukuran sebelum dan sesudah perlakuan. Partisipan penelitian berjumlah 23 siswa kelas IV SD Negeri Srikenca yang dipilih menggunakan teknik sampling jenuh. Data dikumpulkan melalui tes dan dianalisis menggunakan statistik deskriptif, uji normalitas Shapiro Wilk, serta uji paired samples t test dengan bantuan SPSS versi 27. Hasil penelitian menunjukkan bahwa nilai rata rata meningkat dari 40,96 pada pretest menjadi 82,39 pada posttest, dengan selisih sebesar 41,43 poin. Uji paired samples t test menunjukkan perbedaan yang signifikan secara statistik ($p < 0,001$). Temuan ini mengindikasikan bahwa gamifikasi berbantuan Wordwall berpotensi mendukung pembelajaran literasi matematis. Namun, ketiadaan kelompok kontrol membatasi penarikan kesimpulan kausal. Penelitian lanjutan dengan sampel lebih luas dan desain komparatif diperlukan.

Keywords: elementary education, gamification, mathematical literacy, wordwall

Introduction

Mathematics education at the elementary school level plays an important role in developing students' logical reasoning, critical thinking, systematic problem-solving, and decision-making abilities. Beyond mastering computational procedures and mathematical formulas, students need to understand mathematical concepts and apply them to situations encountered in everyday life. This capacity is closely associated with mathematical literacy, which the OECD defines in terms of the ability to formulate, employ, and interpret mathematics in a variety of real-world contexts through mathematical reasoning and the use of mathematical concepts, procedures, and facts (OECD, 2023). Mathematical literacy also involves observing situations, processing relevant information, and communicating mathematical reasoning to

support informed decisions (Umbara & Wahyudin, 2021; Setiawan, 2023). Therefore, elementary mathematics instruction should provide opportunities for students to develop conceptual understanding and apply mathematical knowledge to contextual problems rather than concentrate exclusively on routine calculations.

Despite its importance, the development of mathematical literacy remains a significant challenge in Indonesia. The 2022 Programme for International Student Assessment (PISA) results reported an Indonesian mathematics score of 366, compared with the OECD average of 472, while a substantial proportion of Indonesian students had not achieved Level 2 proficiency (OECD, 2023; Jauhari, 2023). Although these results concern 15-year-old students rather than elementary school pupils, they provide a broader indication of the challenges associated with mathematical literacy in the Indonesian education system. At the elementary level, difficulties may emerge when students are expected to identify relevant information, translate contextual situations into mathematical representations, select appropriate strategies, and interpret their answers. Conventional teacher-centered instruction that emphasizes memorization and procedural practice may provide insufficient opportunities for students to develop these interconnected abilities when conceptual understanding and contextual application are not adequately addressed (Rumani, 2025). Such challenges are particularly relevant to fraction learning, including the comparison of fractions with the same denominator, which requires students to understand the relationship between numerical representations and the quantities they represent (Amelia & Kartini, 2023; Tampangella et al., 2025).

These challenges were also identified in preliminary observations conducted on February 16, 2026, among fourth-grade students at Srikencana Elementary School. The observations indicated that students experienced difficulties identifying relevant information in word problems, representing mathematical situations, selecting the appropriate comparison symbols, and interpreting their answers in relation to the original problems. Classroom instruction also tended to emphasize procedural activities, while interactive digital learning media had not been sufficiently incorporated into the learning process. These initial observations suggest the need to explore instructional approaches that connect mathematical concepts with visual representations, active participation, and opportunities for immediate feedback. One possible approach is gamification, which incorporates game-related elements such as challenges, points, and feedback into learning activities. Previous studies have associated gamification with increased learning motivation and student engagement (Suparmini et al., 2024; Febriansah et al., 2024). Its potential relevance to elementary mathematics can also be considered in relation to Piaget's theory of cognitive development, which places children aged approximately 7–11 years in the concrete operational stage, when concrete representations and meaningful activities can support their understanding of abstract concepts (Syafawani & Safari, 2024; Alfadhilah, 2025). From a social constructivist perspective, Vygotsky's concepts of scaffolding and the Zone of Proximal Development (ZPD) further emphasize the potential importance of appropriate guidance and learning support in developing students' understanding (Salsabilai et al., 2025).

Wordwall offers a digital platform through which gamification principles can be incorporated into mathematics instruction using interactive quizzes, matching activities, and other game-based tasks. Its features can provide repeated practice, automated scoring, and immediate feedback, potentially allowing students to identify errors and reconsider their responses during learning activities (Nursarofah et al., 2024; Kismetova et al., 2025). When applied to fraction comparison, visual prompts and interactive tasks may help students connect

mathematical symbols with representations of quantities, while feedback can support the correction of misconceptions. Nevertheless, the educational value of the platform depends not merely on the availability of digital games but also on how activities are aligned with learning objectives, mathematical concepts, and the skills being assessed. Previous studies have reported the potential of Wordwall to support mathematics learning outcomes and numeracy literacy among elementary school students (Khasanah et al., 2024; Dewi et al., 2025). Other research has examined gamification in relation to critical thinking and mathematical problem-solving, including the use of Wordwall-based learning media (Fauziyati & Sriyanto, 2024; Damayanti et al., 2025). These findings provide a relevant empirical foundation for investigating Wordwall-assisted gamification while also highlighting the importance of distinguishing general learning outcomes from the more specific construct of mathematical literacy.

Although previous studies have examined Wordwall and gamification in educational settings, further investigation is warranted into their application to specific mathematical content and the development of students' mathematical literacy. In particular, the present study focuses on fourth-grade students learning to compare fractions with the same denominator and considers mathematical literacy as more than the ability to obtain correct numerical answers. Its emphasis is on students' engagement with contextual problems, use of mathematical concepts and strategies, problem-solving processes, and interpretation of results. The contribution of this study therefore lies in examining the pretest–posttest performance of students participating in a Wordwall-assisted gamification intervention within a specific elementary mathematics learning context. Rather than claiming that the instructional approach constitutes an entirely new pedagogical innovation, the study seeks to provide context-specific empirical evidence concerning changes in mathematical literacy scores following its implementation. This focus is relevant because the effectiveness of a digital learning approach should be examined in relation to the particular learning objectives, instructional conditions, and student population in which it is applied.

Based on this background, the present study aims to examine the effect of a Wordwall-assisted gamification approach on the mathematical literacy scores of fourth-grade students at Srikenkana Elementary School in learning to compare fractions with the same denominator. A quantitative approach employing a one-group pretest–posttest design is used to compare students' performance before and after the instructional intervention. The analysis focuses on the difference between pretest and posttest scores to determine whether a statistically significant change is observed following the implementation of the approach. The findings are expected to provide practical insights for elementary school teachers considering interactive digital activities as supplementary resources for mathematics instruction. However, because the study does not employ a control group, any observed improvement must be interpreted within the limitations of the research design and should not be regarded as definitive evidence that the intervention alone caused the change. By presenting both the observed results and the limitations of the evidence, this study seeks to contribute a more contextually grounded understanding of Wordwall-assisted gamification in elementary mathematical literacy learning.

Methods

This study employed a quantitative approach using a pre-experimental design, specifically a one-group pretest–posttest design, to examine changes in the mathematical literacy scores of fourth-grade students following a Wordwall-assisted gamification intervention. Quantitative research involves the systematic collection and statistical analysis of numerical data to

investigate research questions (Creswell & Creswell, 2018). In this study, the participants completed a pretest before receiving the instructional intervention and a posttest afterward. The research was conducted with 23 fourth-grade students at Srikencana Elementary School, with all students in the target class included through a saturated sampling technique. This design enabled the researchers to compare students' performance across the two measurement occasions; however, because no control group was included, the findings are interpreted as changes observed following the intervention rather than definitive evidence of a causal effect.

The research procedure consisted of three principal stages: initial assessment, instructional intervention, and final assessment. First, the pretest was administered to assess students' mathematical literacy before the intervention. Second, students participated in mathematics learning using a Wordwall-assisted gamification approach focused on comparing fractions with the same denominator. Third, a posttest was administered to measure students' performance after the instructional activities. Data were collected through tests, classroom observation, and documentation. The test scores served as the primary quantitative data for evaluating changes in mathematical literacy, while observation and documentation provided supplementary information about the learning process. The study design is presented in Table 1.

Table 1. One-Group Pretest–Posttest Research Design

Pretest	Treatment	Posttest
O_1	X	O_2

Note: O_1 = pretest measurement; X = Wordwall-assisted gamification intervention; O_2 = posttest measurement. Adapted to the one-group pretest–posttest design described by Creswell and Creswell (2018).

The data were analyzed using descriptive and inferential statistics with the assistance of IBM SPSS Statistics version 27. Descriptive statistics were used to summarize students' pretest and posttest performance through the mean, standard deviation, minimum score, and maximum score. Before conducting the paired-samples t-test, the Shapiro–Wilk test was used to examine the normality assumption, with particular attention to the distribution of the paired score differences. The paired-samples t-test was subsequently employed to determine whether the mean difference between pretest and posttest scores was statistically significant at the 0.05 significance level. This procedure is appropriate for comparing two measurements obtained from the same participants when the relevant assumptions are satisfied. The statistical results were interpreted in relation to the research objective while recognizing that a single-group design does not rule out alternative explanations for changes in student performance (Creswell & Creswell, 2018; Spurlock, 2018).

Result

Description of Mathematical Literacy Ability Before and After Treatment

The analysis involved 23 fourth-grade students at Srikencana Elementary School who completed both the pretest and posttest on comparing fractions with the same denominator. Before the Wordwall-assisted gamification intervention, students obtained a total pretest score of 965, with a mean of 40.96, a standard deviation of 16.16, a minimum score of 17, and a maximum score of 75. Following the instructional intervention, the total posttest score increased to 1,895, with a mean of 82.39, a standard deviation of 6.14, a minimum score of 71, and a maximum score of 96. These descriptive statistics indicate that the students' average scores were higher after the intervention than before it.

Table 2. Descriptive Statistics of Students' Mathematical Literacy Scores

Pretest		Posttest	
Number of Samples	23	Number of Samples	23
Total Value	965	Total Value	1895
Rate-rate	40,96	Rate-rate	82,39
Standard Deviation	16,16	Standard Deviation	6,14
Minimum Value	17	Minimum Value	71
Maximum Value	75	Maximum Value	96

The difference between the posttest and pretest means was 41.43 points. In addition to the increase in the mean score, the minimum score rose from 17 to 71, while the maximum score increased from 75 to 96. The standard deviation decreased from 16.16 to 6.14, indicating that the posttest scores were less dispersed around the mean than the pretest scores. All 23 students obtained posttest scores of at least 71. These findings describe the observed changes in students' performance between the two measurement occasions; the statistical significance of the difference was examined through the subsequent inferential analysis.

Normality Test Results

Before conducting the paired-samples t-test, the normality of the data was examined using the Shapiro-Wilk test. This test was selected in consideration of the sample size of 23 students. The results showed a significance value of 0.109 for the pretest scores and 0.283 for the posttest scores. Both values exceeded the predetermined significance level of 0.05, indicating that the null hypothesis of normality was not rejected for either set of scores.

Table 3. Shapiro-Wilk Normality Test Results

Measurement	Statistic (W)	df	Sig.
Pretest	0.930	23	0.109
Posttest	0.949	23	0.283

Note. The significance level was set at 0.05. The reported degrees of freedom correspond to the number of students assessed at each measurement occasion.

Although both sets of scores did not show statistically significant departures from normality according to the Shapiro-Wilk test, the assumption relevant to the paired-samples t-test concerns the distribution of the differences between each student's pretest and posttest scores. Therefore, the normality results for the two measurement occasions alone are insufficient to establish that all assumptions of the paired-samples t-test have been satisfied. The paired-difference distribution should also be examined before the inferential findings are interpreted.

Paired-Samples t-Test Results

A paired-samples t-test was used to examine whether the mean difference between pretest and posttest scores was statistically significant. The analysis reported a mean difference of -41.43 points when the scores were calculated as pretest minus posttest. The negative direction reflects the higher average score obtained in the posttest. The test produced a t-value of -12.387 with 22 degrees of freedom and a reported significance value of 0.000, which should be expressed in APA style as $p < .001$.

Table 4. Paired-Samples t-Test Results for Mathematical Literacy Scores

Comparison		Mean difference	Standard deviation	Standard error	95% CI lower	95% CI upper	t	df	Sig. (2-tailed)
Pretest Posttest	-	-41.43	16.042	3.345	-48.372	-34.498	-12.387	22	< .001

Note. CI = confidence interval. The difference was calculated by subtracting posttest scores from pretest scores. The reported significance value of 0.000 is presented as $p < .001$ in accordance with APA reporting conventions.

The 95% confidence interval for the mean difference ranged from -48.372 to -34.498 and did not include zero. Together with the reported test statistic and significance level, this result indicates a statistically significant difference between the students' pretest and posttest scores. The direction of the difference is consistent with the descriptive results, which showed a higher mean score after the intervention. Accordingly, the null hypothesis of no mean difference between the two measurement occasions was rejected at the 0.05 significance level. This finding establishes a statistically significant pretest-posttest difference within the participating group, but the one-group design does not establish that the intervention alone caused the observed change.

Discussion

The findings indicate a substantial difference in the mathematical literacy scores of fourth grade students before and after the implementation of Wordwall assisted gamification. The mean score increased from 40.96 in the pretest to 82.39 in the posttest, representing a difference of 41.43 points. This increase was accompanied by a rise in the minimum score from 17 to 71 and the maximum score from 75 to 96. Furthermore, the standard deviation decreased from 16.16 to 6.14, indicating that the posttest scores were more concentrated around the group mean. The paired samples t test also revealed a statistically significant difference between the two measurements, $t(22) = -12.387$, $p < .001$, with a 95% confidence interval for the pretest and posttest mean difference ranging from -48.372 to -34.498. Taken together, these results demonstrate that the participating students obtained higher mathematical literacy scores after the instructional intervention. Nevertheless, statistical significance does not independently establish causality. Because the study employed a one group pretest and posttest design without a comparison group, the observed improvement may also reflect regular classroom instruction, familiarity with the assessment, or other learning experiences during the study period. The findings should therefore be interpreted as evidence of improved performance following the intervention rather than definitive proof that Wordwall assisted gamification alone caused the change.

One possible explanation for the observed improvement concerns the relationship between visual representation and the conceptual demands of comparing fractions with the same denominator. Although this topic may appear procedurally straightforward, students need to understand the relationship between the numerator, the denominator, and the quantity represented by each fraction. They must also recognize how these relationships determine the appropriate comparison symbol. When instruction emphasizes symbolic procedures without sufficient conceptual explanation, students may learn to reproduce a rule without fully understanding the mathematical reasoning behind it. Interactive activities incorporating visual prompts may provide opportunities to connect numerical expressions with representations of quantities, making the relationships between fractions more accessible to elementary school students. This interpretation is consistent with Piaget's theory of cognitive development, particularly the characteristics of concrete operational thinking discussed in elementary

education (Alfadhilah, 2025; Syafawani & Safari, 2024). From this perspective, visual and contextual representations may support students in developing logical relationships between mathematical objects and symbols. However, the present study did not compare visual and nonvisual instructional conditions or directly measure conceptual understanding. Consequently, the role of visual representation remains a plausible explanation for the observed improvement rather than a mechanism empirically established by the research.

The potential contribution of the intervention can also be considered through Vygotsky's social constructivist perspective, which emphasizes the importance of social interaction and appropriate guidance in learning. The concepts of scaffolding and the Zone of Proximal Development suggest that students may develop more advanced understanding when instructional support helps them engage with tasks that would otherwise be difficult to complete independently (Salsabilai et al., 2025). In a classroom setting, Wordwall activities may be incorporated into teacher guided exercises in which students discuss answers, receive explanations, and reconsider incorrect responses. Such arrangements could provide opportunities for students to refine their mathematical reasoning through interaction with teachers and peers. Nevertheless, the effectiveness of these activities depends on how they are organized and facilitated. A digital platform does not automatically provide meaningful scaffolding merely because it presents interactive questions. Teachers still need to identify misconceptions, explain mathematical relationships, and encourage students to justify their answers. Since the present study did not separately measure peer interaction, teacher guidance, or changes in students' reasoning processes, the contribution of these factors cannot be isolated from the overall score improvement. The theoretical perspective therefore helps explain the potential educational value of the intervention without establishing which learning processes were responsible for the observed change.

Another possible explanation concerns the opportunities for repeated practice and feedback provided by Wordwall. The platform offers interactive formats, including quizzes and matching activities, that can be incorporated into mathematics instruction to encourage students to respond to questions and review their performance (Nursarofah et al., 2024; Kismetova et al., 2025). In learning fraction comparison, these activities may allow students to practice identifying relevant numerical information, selecting appropriate comparison symbols, and checking the accuracy of their responses. When feedback is immediate and understandable, students may have an opportunity to recognize errors and reconsider their answers during the learning process. Previous research has discussed the potential of gamification to support student motivation and participation through game related elements such as challenges, scores, and feedback (Amaliyah, 2024; Febriansah et al., 2024; Suparmini et al., 2024). These perspectives offer a reasonable pedagogical explanation for why interactive learning activities may support mathematics learning. However, motivation, engagement, and feedback use were not reported as separate measured outcomes in this study. It would therefore be inappropriate to conclude that these factors definitively mediated the increase in mathematical literacy scores. Their potential contribution should be examined in future research through classroom observations, student engagement measures, interviews, or comparisons between different instructional formats.

The findings should also be interpreted in relation to the broader concept of mathematical literacy. The OECD (2023) defines mathematical literacy in terms of the ability to formulate, employ, and interpret mathematics in a variety of real world contexts. This conception extends beyond obtaining correct numerical answers because it involves identifying relevant

information, selecting mathematical representations, applying appropriate strategies, and interpreting results in relation to the original problem. Iryanto and Aminah (2024) provide an additional reference for considering mathematical literacy in relation to students' mathematical learning. In the context of fraction comparison, these abilities may be reflected in students' capacity to recognize the information presented in a contextual problem, establish the mathematical relationship between quantities, select a suitable comparison procedure, and explain the meaning of the result. The increase in overall assessment scores observed in this study is consistent with improved performance on the mathematical literacy test administered to the students. However, the available results do not provide separate statistical analyses for each literacy indicator. It is therefore not possible to determine whether all dimensions improved equally or whether the overall increase was concentrated in particular aspects of the assessment. Future investigations could report indicator level scores, examine students' errors, and assess their ability to explain mathematical reasoning in unfamiliar contexts to establish a more detailed understanding of the relationship between Wordwall assisted gamification and mathematical literacy.

The present findings are broadly consistent with previous research examining Wordwall and gamification in educational settings. Khasanah et al. (2024) investigated the use of Wordwall in mathematics learning in relation to literacy and numeracy outcomes, while Dewi et al. (2025) reviewed research on the effectiveness of Wordwall interactive media in elementary mathematics education. Other studies have examined Wordwall based activities and gamification in relation to critical thinking and mathematical problem solving (Fauziyati & Sriyanto, 2024; Damayanti et al., 2025). Collectively, these studies provide a relevant context for considering the use of interactive digital media to support learning. Nevertheless, their findings should not be treated as directly equivalent because the studies may differ in participants, learning materials, instructional procedures, research designs, and outcome measures. For example, evidence concerning critical thinking in social studies or mathematical problem solving does not automatically establish an equivalent effect on mathematical literacy in fraction comparison. The contribution of the present study lies in examining pretest and posttest changes among fourth grade students learning to compare fractions with the same denominator in a specific elementary school context. This provides context specific empirical evidence, although further comparative research is needed to determine whether similar changes occur under different instructional conditions and among other student populations.

Several limitations should be considered when interpreting the findings. First, the study involved 23 students from a single fourth grade class, limiting the extent to which the results can be generalized to other schools and educational settings. Second, the absence of a control group prevents the researchers from distinguishing the contribution of the intervention from other influences, including regular instruction, familiarity with the test format, and changes in students' knowledge over time. Third, the reported results focus on aggregate pretest and posttest scores and do not establish whether the improvement was maintained over a longer period or transferred to other mathematical topics. In addition, the available results do not establish whether the assessment instrument measured each dimension of mathematical literacy with sufficient validity and reliability. These limitations do not negate the observed score difference, but they define the boundaries of the conclusions that can reasonably be drawn. Future research could involve multiple schools, employ comparison groups, document the instructional procedures in greater detail, validate the assessment instrument, and include delayed posttests to examine the persistence of learning. Analyzing individual score changes

and separate literacy indicators would also help explain how students with different initial performance levels respond to the intervention.

From a practical perspective, the findings suggest that Wordwall assisted gamification may be considered a supplementary resource for teaching mathematical concepts, particularly fraction comparison, when its activities are aligned with the intended learning outcomes. Teachers could combine interactive questions with visual explanations, guided practice, classroom discussion, and opportunities for students to justify their mathematical choices. This combination is important because successful mathematical learning requires more than selecting the correct answer in a digital game. Students also need to understand the underlying concepts and apply them in different contexts. Teachers should therefore use the platform to complement instructional explanations and formative assessment rather than as a substitute for them. Overall, the substantial and statistically significant increase in students' scores provides a promising basis for further investigation of Wordwall assisted gamification in elementary mathematics education. However, the findings should be understood within the limitations of the research design and the outcomes actually measured. More rigorous comparative studies, supported by validated assessment instruments and analyses of individual mathematical literacy indicators, are needed to determine the extent to which this approach contributes to sustained conceptual understanding and broader mathematical literacy development.

Conclusion

The findings indicate a substantial improvement in the mathematical literacy scores of fourth grade students following the implementation of Wordwall assisted gamification. The mean score increased from 40.96 on the pretest to 82.39 on the posttest, representing an average difference of 41.43 points. The paired samples t test also revealed a statistically significant difference between the two measurements ($p < .001$). These results suggest that integrating Wordwall into mathematics instruction may provide a useful approach to supporting students' learning, particularly when interactive digital activities are incorporated into classroom practice. Nevertheless, the findings should be interpreted as evidence of improvement observed after the intervention rather than definitive proof that Wordwall alone caused the increase.

This study has limitations that should be considered when interpreting its findings. The research involved only 23 students from one fourth grade class and did not include a control group, which limits the extent to which the results can be generalized or attributed exclusively to the intervention. Further studies should involve larger and more diverse student groups, compare Wordwall assisted instruction with alternative teaching approaches, and examine the effectiveness of the intervention over a longer period. Future research could also assess specific dimensions of mathematical literacy to identify which aspects of students' performance benefit most from interactive gamification. Such investigations would provide a stronger basis for determining how Wordwall can be integrated effectively into elementary mathematics education.

References

- Alfadhilah, J. (2025). Philosophy of early childhood education according to Jean Piaget. *Alzam: Journal of Islamic Early Childhood Education*, 5(1), 94–111.
<https://doi.org/10.51675/alzam.v5i1.1092>

- Amaliyah, F. (2024). Literature review: Gamification-based Wordwall application as an evaluation of elementary school mathematics learning. *Inventa: Journal of Elementary School Teacher Education*, 8(2), 110–121. <https://doi.org/10.36456/inventa.8.2.a9595>
- Amelia, R., & Kartini, K. (2023). Mathematical literacy in elementary geometry learning. *Journal of Primary Education Research*, 12(2), 145–158.
- Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). SAGE Publications.
- Damayanti, D., Wahyuni, R., & Rosmaiyadi. (2025). Application of the Make A Match cooperative learning model assisted by Wordwall media on the mathematical problem-solving abilities of fifth-grade elementary school students. *Journal of Specialized Basic Education*, 11(2), 1085–1093. <https://doi.org/10.31932/jpdp.v11i2.4848>
- Dewi, M., Apriza, B., & B, D. K. (2025). The effectiveness of Wordwall interactive media in teaching mathematics in elementary school: A systematic literature review. *Undiksha Elementary School Teacher Education Podium*, 13(1), 127–137. <https://doi.org/10.23887/jipgsd.v13i1.92352>
- Fauziyati, K. A., & Sriyanto, S. (2024). STEM-based Wordwall Labeled Diagram gamification learning media for elementary school students' critical thinking in social studies learning. *DIDAKTIKA: Journal of Elementary School Education*, 6(2), 91–98. <https://doi.org/10.21831/didaktika.v6i2.62031>
- Febriansah, A. T., Syaifuddin, A., & Soepriyanto, Y. (2024). Gamification developments in education. *Scholaria: Journal of Education and Culture*, 14(2), 177–186. <https://doi.org/10.24246/j.js.2024.v14.i2.p177-186>
- Iryanto, W., & Aminah, N. (2024). Analysis of students' mathematical literacy in terms of Adversity Quotient. *Journal of School Mathematics Learning Research (JP2MS)*, 8(1), 13–22. <https://doi.org/10.33369/jp2ms.8.1.13-22>
- Jauhari, S. S. (2023). *Indonesia's PISA score comparison from year to year shows a decline in 2022*. GoodStats Data. <https://data.goodstats.id/statistic/sarahjauhari/perbandingan-skor-pisaindonesia-dari-tahun-ke-tahun-alami-penurunan-pada-2022-TKKZ3>
- Khasanah, F. U., Majid, A., & Fatiatun. (2024). The effectiveness of using the Wordwall platform in mathematics learning on the literacy and numeracy skills of grade V students of SD Negeri 1 Lengkong Garung. *Journal of Education and Teaching Review*, 7(2), 3988–3996. <https://doi.org/10.31004/jrpp.v7i2.26470>
- Kismetova, G., & Agniyazova, A. (2025). The effectiveness of using the Wordwall platform in developing students' lexical and grammatical competences at the intermediate stage of philological education. *Journal of Philology and Education*, 35(3), 271–278. <https://doi.org/10.62724/202530306>
- Nursarofah, N., Gandana, G., & Rahman, T. (2024). The interactive Wordwall game as an innovation in digital learning media for early childhood. *Early Childhood Education Pelita Journal*, 9(1), 78–85. <https://doi.org/10.33222/pelitapaud.v9i1.3900>
- OECD. (2023). *PISA 2022 results: The state of learning and equity in education* (Vol. I). OECD Publishing. <https://www.oecd.org/indonesia/>
- Rumani, P. (2025). Comparison of conventional and contextual mathematics learning in elementary schools. *Aksioma Education Journal*, 2(3), 42–55. <https://doi.org/10.62872/aej.v2i3.30>
- Salsabilai, A., Marsithah, I., Mulina, C., & Nurlia, C. (2025). The role of psychological foundations in elementary school students' learning: A literature study of Piaget's and Vygotsky's

- theories. *Journal of Elementary School Teacher Education*, 2(4), 88–97.
<https://doi.org/10.47134/pgsd.v2i4.1806>
- Setiawan, A. R. (2023). Mathematical literacy for elementary level. *Basicedu Journal*, 7(3), 1724–1735. <https://doi.org/10.31004/basicedu.v7i3.5646>
- Suparmini, K., Suwindia, I. G., & Winangun, I. M. A. (2024). Gamification to increase student learning motivation in the digital era. *Education and Social Sciences Review*, 5(2), 145–154. <https://doi.org/10.29210/07essr500200>
- Syafawani, U. R., & Safari, Y. (2024). Jean Piaget's theory of cognitive psychological learning development: Implementation in mathematics learning in elementary school. *The Wisdom of Monotheism*, 3(2), 1488–1502.
- Tampangella, T., Ulfah, N. D., & Triono, A. (2025). Analysis of students' learning difficulties in mathematics subjects in grade III of elementary school. *JOGRACI: Journal of Global Research and Contemporary Issue*, 1(1), 72–86.
- Umbara, U., & Wahyudin. (2021). *Mathematical literacy, ethnomathematics, and ethnomodeling: Based on historical, philosophical, and practical reviews*. Refika Aditama.