



Development of Wordwall-Assisted Educational Game Media on Fractions to Improve Mathematical Literacy in Elementary School Students

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ABSTRACT

This study aims to develop Wordwall-assisted educational game media on fraction material to improve the mathematical literacy of elementary school students. The low scores of Indonesian students in international assessments such as PISA 2022, combined with the abstract nature of fraction concepts and the dominance of teacher-centered conventional instruction, highlight the urgent need for innovative, technology-integrated learning media. This research employs a Research and Development (R&D) approach using the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). The subjects included material, media, and language expert validators, 15 teachers for feasibility testing, and 38 fifth-grade students at SDN Batukarut, Sukaraja, Sukabumi, as the experimental group. Data were collected through expert validation sheets, teacher and student response questionnaires, and mathematical literacy tests. Results indicate that the developed Wordwall-based educational game achieved a "very valid" rating from expert validators. Teacher and student responses were both categorized as "very good." The effectiveness test using a one-group pretest-posttest design showed a significant improvement in students' mathematical literacy, with an N-gain value in the medium-high category. This study recommends the integration of Wordwall-assisted educational games as a standard digital learning medium in elementary mathematics classrooms, particularly for abstract topics such as fractions.

Keywords: ADDIE model; educational game; fractions; mathematical literacy; wordwall

INTRODUCTION

Mathematical literacy is a fundamental competency that every student must possess to navigate the demands of the 21st century (OECD, 2022; Stacey, 2011). According to the OECD (2022), mathematical literacy refers to an individual's capacity to formulate, employ, and interpret mathematics in a variety of real-world contexts. This competency is considered essential not only for academic success but also for enabling productive participation in society, informed decision-making, and critical reasoning in everyday life (Cai et al., 2020; National Council of Teachers of Mathematics [NCTM], 2000). However, data from the Programme for International Student Assessment (PISA) 2022 revealed that Indonesia ranked 69th out of 81 countries, with an average score of 366 points well below the OECD mean and far from the minimum Level 2 threshold considered necessary for productive societal participation (OECD, 2022). This persistent underperformance reflects deeply rooted challenges in Indonesian mathematics education, particularly the predominance of procedural, rote-based instruction that neglects the development of higher-order thinking and contextual reasoning skills (Stacey, 2011; Fitri & Pahlevi, 2020). At the elementary

school level, fractions constitute one of the most conceptually challenging topics, demanding strong abstract thinking, visualization skills, and numerical reasoning (Gabriel et al., 2013; Keijzer & Terwel, 2003; Pantziara & Philippou, 2012). Research consistently shows that students who develop poor fraction understanding in primary school are at significantly higher risk of difficulty in later mathematical topics, including algebra, ratio, and proportion (Zhang & Lin, 2020; Mardati & Febrilia, 2023). Preliminary data collected from 440 fifth-grade students across Cluster II, Sukaraja Sub-district, Sukabumi, showed that 68% struggled with basic fraction concepts such as comparing, ordering, and performing operations, while only 22% could solve real-life contextual problems involving fractions. This finding aligns with (Nisa, 2022), who identified conceptual misunderstanding and procedural rigidity as the two primary obstacles to fraction mastery among elementary students in Indonesia. This situation is compounded by the continued dominance of teacher-centered, conventional instructional approaches that fail to engage students actively or meaningfully connect abstract mathematical ideas to everyday experience (Anriana et al., 2024; Ratnasari & Ginanjar, 2019).

Several prior studies have examined the intersection of digital game-based learning and mathematics education at the elementary level, providing a strong empirical foundation for the present research. Demonstrated that technology-based educational game media can significantly enhance students' conceptual understanding and motivation in elementary mathematics, with effect sizes consistently surpassing those of conventional instruction (Sulisworo and Yuliati, 2019). Found that Wordwall, as an interactive platform, accelerates mastery of foundational mathematical concepts by providing immediate feedback and engaging practice routines that sustain student attention and reduce mathematics anxiety (Darmawan and Lestari, 2020). Showed that technology-based educational games help students grasp fraction material more readily through visual representation and interactive features, noting a 23.4% average improvement in posttest scores compared to a control group (Husna and Idris, 2021). Confirmed that interactive technology-assisted learning media, including Wordwall, effectively supports conceptual understanding in mathematics, particularly for topics demanding visual reasoning such as fractions, and further reported improved student motivation and learning persistence across multiple instructional sessions (Windiyani and Jaenudin, 2018, 2019). Further demonstrated that applying Wordwall-assisted learning media to fraction content in elementary school yielded significant improvements in student comprehension, especially in simplification, comparison, and basic fraction operations (Alimudin and Fitriani, 2023). Additionally established through a quasi-experimental design that gamification-based platforms such as Wordwall produce measurable gains in mathematics learning motivation and achievement, with students in the gamified condition outperforming controls on both affective and cognitive measures (Yildirim and Kiray, 2021).

Building on this foundation, additional studies reinforce the value of game-based digital media in elementary mathematics and provide theoretical grounding for the present study. Found that digital game-based approaches offer clearer visual representations of fraction concepts, with students directly interacting with material to receive immediate corrective feedback, resulting in significant reductions in systematic errors (Jaenudin and Windiyani, 2020). Reported that students learning with Wordwall-assisted educational

games on fraction content demonstrated higher mathematical literacy than peers taught through traditional methods, attributing this to the visual, interactive, and contextually embedded nature of game-based learning (Setiawan, 2020). Which synthesised 65 experimental and quasi-experimental studies, confirmed that game-based learning consistently produces moderate-to-large positive effects on mathematics achievement across grade levels and content domains, strongly supporting the use of educational games for fraction instruction (The meta-analytic work of Tokac et al., 2019). In the PRISMA journal, highlighted that problem-based learning integrated with technology tools increases mathematical connection ability and motivation in junior high students, a finding with strong implications for primary-level digital media design (Septian and Komala, 2019). Showed that multimedia-assisted learning through the Somatic, Auditory, Visualization, Intellectually (SAVI) model improves mathematical representation skills, indicating the central role of multimodal, interactive media in developing higher-order mathematical thinking. A further PRISMA-published study by (Monariska and Septian, 2021) established that the integration of GeoGebra-assisted collaborative learning strengthens students' problem-solving and conceptual fluency, lending theoretical credibility to technology-mediated interactive approaches in mathematics classrooms (Septian et al., 2020). Further underscored the theoretical basis for developing structured instructional materials that align with curriculum objectives, a principle central to the ADDIE-based design adopted in the present study (Prastowo, 2021). Additionally demonstrated the effectiveness of Wordwall in developing fraction equivalence understanding at the elementary level, showing a significant gain in student achievement following media-integrated instruction (Wahyu Ningtia and Rahmawati, 2022).

Despite this growing body of evidence, a significant gap persists in the literature. The majority of existing studies focus narrowly on improvements in learning outcomes or student motivation, without addressing how Wordwall-assisted educational game media can specifically and systematically target the multiple dimensions of mathematical literacy namely, the ability to formulate, employ, and interpret mathematics across real-world contexts, as operationalized by the OECD framework and reflected in Indonesia's Minimum Competency Assessment (AKM) (OECD, 2019, 2022). Furthermore, no prior study identified in the Indonesian literature has employed the comprehensive ADDIE development model to rigorously validate and test Wordwall-based game media on fraction content at the elementary level while simultaneously measuring all three literacy dimension gains through standardized N-gain analysis. Most existing studies either evaluate Wordwall as a supplementary tool without an explicit development framework, or they target a single literacy subdomain rather than the full OECD competency spectrum. The absence of a research-based, validated Wordwall media product that is explicitly designed to address all three mathematical literacy dimensions and that has undergone multi-expert validation and empirical effectiveness testing constitutes a clear and significant gap that the present study seeks to fill. Accordingly, the central research problem addressed by this study is: How can Wordwall-assisted educational game media be systematically developed and empirically validated to improve the mathematical literacy of fifth-grade elementary school students on fraction content, encompassing all three OECD literacy dimensions.

The novelty of this research lies in the development and empirical testing of Wordwall-assisted educational game media that is specifically engineered through the ADDIE development model to enhance all dimensions of mathematical literacy (formulation, employment, and interpretation) for fifth-grade fraction content. Unlike prior studies that use Wordwall incidentally or evaluate it solely on the basis of learning outcomes or user response, this research integrates mathematical literacy indicators directly into the game design architecture from the outset, ensuring that every interactive element quizzes, matching activities, contextual problem scenarios is aligned with OECD literacy competency descriptors. This represents an original contribution to the field of elementary mathematics education in Indonesia.

The development of rigorously validated Wordwall-based educational game media holds strategic implications at multiple levels. Pedagogically, it equips teachers with a ready-to-implement, empirically tested digital resource that addresses one of the most persistent challenges in elementary mathematics education. For students, it transforms the learning of abstract fraction concepts into an engaging, contextualized, and cognitively stimulating experience directly targeting the mathematical literacy deficit that underpins Indonesia's low PISA rankings. At the policy level, findings from this study can inform decisions by the Ministry of Education regarding technology integration in the Merdeka Curriculum, particularly in designing AKM-aligned learning activities. More broadly, the validated ADDIE development framework and Wordwall media design principles established in this study serve as a replicable template for developing game-based learning media across other challenging topics and grade levels in Indonesian elementary education.

RESEARCH METHODS

This study employs a Research and Development (R&D) approach, which is a systematic process aimed at designing, developing, and evaluating instructional products to meet specific educational objectives (Sugiyono, 2019). The development model adopted is ADDIE (Analysis, Design, Development, Implementation, Evaluation), selected for its iterative, needs-driven structure that ensures the resulting product is valid, practical, and effective. The research design for effectiveness testing uses a one-group pretest-posttest design (pre-experimental), in which mathematical literacy scores are measured before and after intervention with the developed Wordwall-based game media. This design enables direct comparison of student performance gains attributable to the instructional intervention.

The data in this study are of two types: quantitative and qualitative. Quantitative data were obtained from expert validation scores, teacher and student response questionnaires, and mathematical literacy test results (pretest and posttest). Qualitative data were gathered through open-ended comments in validation sheets and structured interviews with teachers. Data sources include: (1) three expert validators a material expert, a media expert, and a language expert, all of whom are lecturers with relevant specializations; (2) 15 classroom teachers from several elementary schools in Sukaraja Sub-district, Sukabumi, involved in the feasibility assessment; and (3) 38 fifth-grade students at SDN Batukarut, Sukaraja, Sukabumi, who served as the experimental group for effectiveness testing. The study was conducted from January to April 2025.

Data were collected through multiple instruments, each calibrated to specific research objectives. Expert validation data were gathered using structured validation sheets assessing material appropriateness, media design quality, and linguistic clarity, with items rated on a four-point Likert scale. Teacher and student response data were collected via questionnaires administered after product implementation. Mathematical literacy was assessed using a 20-item multiple-choice test contextualized around real-life fraction problems and aligned with OECD mathematical literacy competency descriptors (formulate, employ, interpret). Instrument validity was confirmed through expert judgment and a pilot test in a comparable class, while reliability was established using Cronbach's alpha coefficient in SPSS. The research procedure followed the five ADDIE stages sequentially, with revision loops embedded at each phase based on validator feedback.

Data analysis was conducted using two complementary approaches. Feasibility analysis applied Content Validity Ratio (CVR) and Content Validity Index (CVI) calculations to validator data, with a CVI score ≥ 0.70 indicating acceptability. Qualitative responses were analysed descriptively. Effectiveness analysis employed normalized gain (N-gain) scores to quantify learning improvement, calculated as $N\text{-gain} = (\text{posttest score} - \text{pretest score}) / (\text{maximum score} - \text{pretest score})$, with categories of low (< 0.30), medium ($0.30\text{--}0.70$), and high (> 0.70). The Wilcoxon Signed-Rank Test was applied to determine whether the observed score improvement was statistically significant ($p < 0.05$), given that data failed the normality assumption as confirmed by the Shapiro-Wilk test in SPSS.

RESULTS AND DISCUSSION

ADDIE Development Process

The development of Wordwall-assisted educational game media followed the five-phase ADDIE model as illustrated in Figure 1. In the Analysis phase, a needs assessment survey administered to 32 students revealed that 83.3% prefer learning with media incorporating images, animation, video, and colour, while 91.7% reported no difficulty using digital devices for learning. Among 7 teachers surveyed, 100% agreed that media is a critical factor in learning success, yet 71% had never used educational game media in their classrooms. The Analysis phase confirmed that Wordwall-based game media represents a practical and highly relevant solution to the identified instructional gap.

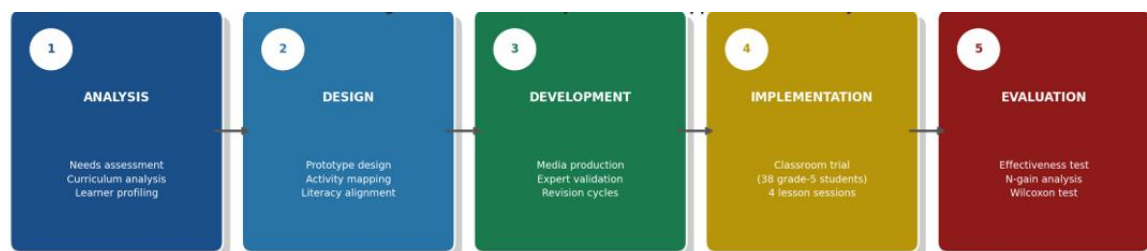


Figure 1. ADDIE Development Model Applied in This Study

In the Design phase, researchers developed a prototype Wordwall game consisting of five activity types: multiple-choice quizzes, fraction matching, contextual story problem sets, a fraction ordering wheel, and a mixed-review challenge. Each activity was mapped directly to the three OECD mathematical literacy competencies (formulate, employ, interpret) and to fifth-grade Merdeka Curriculum fraction learning objectives. In the

Development phase, the prototype was produced, submitted to expert validators, revised according to feedback, and subjected to instrument reliability testing. In the Implementation phase, the validated media was introduced to 38 fifth-grade students over four consecutive lesson sessions. In the Evaluation phase, pretest and posttest data were collected and analysed to determine effectiveness.

Expert Validation Results

Table 1. Expert Validation Results for Wordwall-Assisted Educational Game Media

No.	Validation Dimension	CVR	CVI	Category
A	Material Feasibility	0.93	0.68	Very Good
B	Media Design Feasibility	0.93	0.75	Very Good
C	Language Feasibility	0.97	0.77	Very Good
	Total Average	0.94	0.73	Very Good

The overall CVR value of 0.94 confirms that all media components are considered highly essential by the experts. The consolidated CVI of 0.73 establishes content validity in the 'Very Good' category, consistent with the threshold recommended by Lawshe (1975) for content validation panels. Qualitative feedback from the material expert highlighted the strong alignment between game content and Merdeka Curriculum fraction learning objectives, while the media expert commended the clean visual layout and navigational intuitiveness of the Wordwall interface. The language expert noted appropriate vocabulary level for fifth-grade learners and suggested minor clarifications in three problem items, all of which were incorporated into the revised product.

Teacher and Student Response

Following the implementation phase, responses from 15 teachers and 38 students were collected using structured questionnaires. Teacher responses regarding ease of integration, instructional alignment with the Merdeka Curriculum, and perceived student engagement averaged 91.4%, categorized as 'Very Good.' Student responses regarding motivation, clarity of instructions, game enjoyment, and perceived learning benefit averaged 96.8%, also in the 'Very Good' category. These findings are consistent with Darmawan and Lestari (2020) and Alimudin and Fitriani (2023), who reported similarly high positive responses when Wordwall was deployed in elementary mathematics contexts, indicating that the platform's design characteristics immediate feedback, visual engagement, and competitive elements are well-received by both teachers and students in Indonesian primary schools. The exceptionally high student response rate (96.8%) is noteworthy: it surpasses the 80% threshold typically associated with the 'Very Good' category in Indonesian educational product assessment frameworks (Prastowo, 2021), suggesting that the game design successfully aligned with fifth-grade students' motivational profiles and digital learning preferences. This finding is particularly significant given that 71% of participating teachers had never previously used educational game media in their classrooms, yet still rated the Wordwall media as highly integrable and instructionally appropriate. The high student response rate further suggests that the game effectively created a low-anxiety learning atmosphere a condition identified by (Setiawan, 2020) and (Tokac et al., 2019) as

pivotal for enhancing mathematical literacy engagement and reducing the affective barriers that often inhibit fraction learning.

Mathematical Literacy Improvement (Pretest–Posttest)

Table 1. Pretest and Posttest Mathematical Literacy Scores

Description	Pretest	Posttest
Number of Students	38	38
Minimum Score	20	60
Maximum Score	65	100
Mean Score	38.42	82.76
Standard Deviation	11.83	10.47
Average N-Gain	0.72 (High Category)	

The mean score increased substantially from 38.42 in the pretest to 82.76 in the posttest, representing a gain of 44.34 points. The normalized N-gain value of 0.72 places the learning improvement in the 'High' category (N-gain > 0.70), demonstrating that the Wordwall-based game media was highly effective in improving students' mathematical literacy on fraction content. The Wilcoxon Signed-Rank Test confirmed that this improvement was statistically significant ($Z = -5.38$, $p = 0.000$, $p < 0.05$), ruling out the possibility that the gains were due to chance.

N-Gain Distribution by Mathematical Literacy Dimension

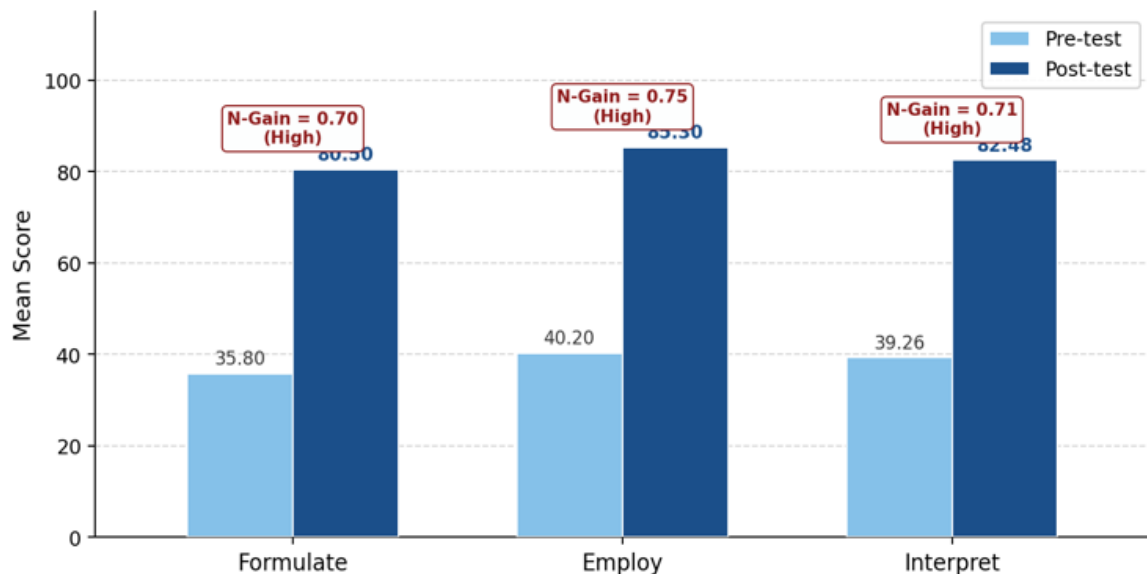


Figure 2. N-Gain Scores Across Three OECD Mathematical Literacy Dimensions

All three mathematical literacy dimensions achieved N-gain scores in the 'High' category (≥ 0.70). The 'Employ' dimension recorded the highest gain (0.75), reflecting the game's strength in providing multiple practice opportunities for applying fraction procedures in varied problem scenarios. The 'Formulate' dimension (0.70) also showed strong improvement, supported by contextual story problems within the game that required students to translate real-world situations into mathematical representations. The 'Interpret' dimension (0.71) benefited from game activities requiring students to explain and justify

their answers within the game interface. These results substantiate the claim that the designed game content successfully targeted all three OECD literacy dimensions.

The convergence of high validation scores, very positive user responses, and statistically significant N-gain values in the high category provides strong evidence that the developed Wordwall-assisted educational game is a valid, practical, and effective learning medium for improving mathematical literacy in fifth-grade fraction instruction. These findings align (Husna and Idris, 2021), who found that technology-based educational games facilitate deeper fraction understanding through visual and interactive engagement, and extend their work by demonstrating that the positive effects are measurable not only through conventional achievement scores but across all three dimensions of the OECD mathematical literacy framework. The results also corroborate the findings of Septian and Komala (2019) and (Septian et al. 2020), who demonstrated that multimodal, technology-integrated learning approaches significantly strengthen both mathematical understanding and higher-order thinking skills—a finding replicated here in the context of elementary fraction instruction. Critically, the consistent high N-gain across all three mathematical literacy dimensions (Formulate: 0.70; Employ: 0.75; Interpret: 0.71) distinguishes this study from prior work, which typically reported only aggregate gains, and directly addresses the identified research gap by confirming that game-based media can be deliberately designed to target each OECD literacy subdimension. This study thus extends the existing literature by providing the first empirical evidence, in the Indonesian elementary context, that ADDIE-developed Wordwall media specifically engineered around the formulate-employ-interpret framework produces high-category gains across all three dimensions simultaneously.

The effectiveness of the media can be attributed to three interrelated pedagogical mechanisms. First, the contextualized problem design bridges abstract fraction concepts with real-world scenarios, directly stimulating the ‘formulate’ and ‘interpret’ literacy competencies by requiring students to translate everyday situations into mathematical representations and to justify their solutions in contextually meaningful terms (Gabriel et al., 2013; Cai et al., 2020). Second, the immediate, automated feedback provided by Wordwall supports self-correction and reduces learned helplessness—a pattern widely observed in students with weak fraction foundations by allowing students to reattempt problems and observe the consequences of their reasoning in real time (Darmawan & Lestari, 2020). Third, the gamification elements competitive scoring, time challenges, and visual rewards—maintain motivational engagement throughout the learning session, activating intrinsic motivation mechanisms that have been theoretically linked to deeper information processing and longer-term retention (Yildirim & Kiray, 2021; Tokac et al., 2019). These mechanisms are consistent with Jaenudin and Windiyani (2020), who emphasized that digital game-based approaches offering direct interaction and immediate feedback are superior to conventional methods for abstract mathematical concepts. From an instructional design perspective, the effectiveness of this study’s product supports the validity of the ADDIE model as a development framework for elementary mathematics media in Indonesia, as its iterative validation loops ensured that the final product was both content-accurate and pedagogically optimised (Ratnasari & Ginanjar, 2019). The theoretical contribution of this study lies in demonstrating that the OECD mathematical literacy framework can serve not only as an assessment construct but as a design blueprint for interactive educational media—a

contribution that has implications for curriculum designers, textbook developers, and technology-integrated lesson planners across Indonesian elementary mathematics education. Regarding study limitations, the single-school, single-group experimental design constrains the external validity and generalizability of the findings. The absence of a control group means that observed gains cannot be exclusively attributed to the Wordwall media, as factors such as teacher enthusiasm, novelty effects, or increased time-on-task may have contributed to improvement. Additionally, the four-session implementation period may be insufficient to capture long-term retention effects. Future research should employ randomized controlled trial designs with control groups across multiple schools and diverse socioeconomic contexts to establish more robust causal claims, and should include delayed posttests to examine the durability of literacy gains.

CONCLUSION

This study successfully developed Wordwall-assisted educational game media for fifth-grade fraction content, designed to improve elementary students' mathematical literacy across the formulate, employ, and interpret dimensions of the OECD framework. Expert validation confirmed that the media is highly valid (CVI = 0.73), teacher and student responses were categorized as 'Very Good' (91.4% and 96.8% respectively), and the one-group pretest-posttest effectiveness test yielded an N-gain of 0.72 in the 'High' category, with statistical significance confirmed by the Wilcoxon Signed-Rank Test ($p = 0.000$).

On the basis of these findings, this study recommends that Wordwall-assisted educational game media be integrated as a standard digital learning resource in elementary mathematics classrooms, particularly for abstract and challenging topics such as fractions. Future research should investigate the long-term retention effects of game-based fraction learning, extend the ADDIE-based development framework to other elementary mathematics topics, and employ randomized controlled trial designs with broader and more diverse student samples to strengthen causal inference.

REFERENCES

- Alimudin, A., & Fitriani, F. (2023). Penerapan Media Pembelajaran Berbantuan Wordwall Pada Materi Pecahan di Sekolah Dasar. *Jurnal Pendidikan Dasar*, 14(2), 112–125. <https://doi.org/10.21831/jpd.v14i2.5123>
- Anriana, A., Mauluah, L., Hastuti, W., & Wibowo, T. (2024). Strategi Pengenalan Konsep Pecahan melalui Media Konkret di Kelas IV Sekolah Dasar. *Jurnal Pendidikan Matematika Raflesia*, 9(1), 45–58. <https://doi.org/10.33449/jpmr.v9i1.1234>
- Cai, J., Morris, A., Hohensee, C., Hwang, S., Robison, V., Cirillo, M., Kramer, S. L., Hiebert, J., & Bakker, A. (2020). Maximizing The Quality of Learning Opportunities for Every Student. *Journal for Research in Mathematics Education*, 51(1), 12–22. <https://doi.org/10.5951/jresmetheduc.2019.0005>
- Darmawan, A., & Lestari, F. (2020). Pemanfaatan Wordwall sebagai Alat Peningkatan Pemahaman Matematika Siswa Sekolah Dasar. *Jurnal Inovasi Pendidikan Dasar*, 5(1), 33–44. <https://doi.org/10.21831/jipd.v5i1.3321>
- Fitri, M., & Pahlevi, T. (2020). Implementasi Model Pengembangan Four-D dalam Pembelajaran Matematika. *Jurnal Penelitian Pendidikan*, 37(2), 189–202. <https://doi.org/10.17509/jpp.v37i2.26543>

- Gabriel, F., Coché, F., Szucs, D., Carette, V., Rey, B., & Content, A. (2013). A Componential View of Children's Difficulties in Learning Fractions. *Frontiers in Psychology*, 4, 715. <https://doi.org/10.3389/fpsyg.2013.00715>
- Husna, S., & Idris, I. (2021). Penggunaan Media Game Edukatif Berbasis Teknologi Digital untuk Meningkatkan Pemahaman Materi Pecahan Siswa Sekolah Dasar. *Jurnal Pendidikan Sains*, 9(2), 88–97. <https://doi.org/10.17977/jps.v9i2.5671>
- Jaenudin, D., & Windiyani, T. (2020). Pendekatan Berbasis Teknologi Digital dalam Pembelajaran Pecahan di Sekolah Dasar. *Jurnal Pendidikan Matematika Indonesia*, 8(3), 120–131. <https://doi.org/10.26737/jpmi.v8i3.1892>
- Keijzer, R., & Terwel, J. (2003). Learning for Mathematical Insight: A Longitudinal Comparative Study on Modelling. *Learning and Instruction*, 13(3), 285–304. [https://doi.org/10.1016/S0959-4752\(02\)00003-8](https://doi.org/10.1016/S0959-4752(02)00003-8)
- Lawshe, C. H. (1975). A Quantitative Approach to Content Validity. *Personnel Psychology*, 28(4), 563–575. <https://doi.org/10.1111/j.1744-6570.1975.tb01393.x>
- Mardati, A., & Febrilia, B. R. A. (2023). Pemahaman Konsep Pecahan Siswa Sekolah Dasar melalui Pendekatan RME. *Jurnal Ilmiah Pendidikan Matematika*, 12(1), 77–89. <https://doi.org/10.26740/mathedunesa.v12n1.p77-89>
- Monariska, E., & Septian, A. (2021). Penerapan Pembelajaran Kolaboratif Berbantuan Geogebra untuk Meningkatkan Kemampuan Pemecahan Masalah Matematis Siswa. *PRISMA*, 10(1), 22–34. <https://doi.org/10.35194/jp.v10i1.1124>
- Nisa, A. (2022). Analisis Kesulitan Siswa Kelas V SD dalam Menyelesaikan Soal Pecahan. *Jurnal Basicedu*, 6(3), 4201–4210. <https://doi.org/10.31004/basicedu.v6i3.2890>
- National Council of Teachers of Mathematics. (2000). *Principles and Standards for School Mathematics*. NCTM.
- OECD. (2019). PISA 2018 results (Volume I): *What Students Know And Can Do*. OECD Publishing. <https://doi.org/10.1787/5f07c754-en>
- OECD. (2022). PISA 2022 results (Volume I): *The State of Learning and Equity in Education*. OECD Publishing. <https://doi.org/10.1787/53f23881-en>
- Pantziara, M., & Philippou, G. N. (2012). Levels of Students' "Conception" of Fractions. *Educational Studies in Mathematics*, 79(1), 61–83. <https://doi.org/10.1007/s10649-011-9338-9>
- Prastowo, A. (2021). *Pengembangan Bahan Ajar Tematik: Tinjauan Teoretis dan Praktis (Edisi Revisi)*. Kencana.
- Ratnasari, D., & Ginanjar, A. Y. (2019). Penerapan Model Pengembangan ADDIE dalam Merancang Media Pembelajaran Interaktif Berbasis ICT. *Jurnal Teknologi Pendidikan*, 21(1), 28–42. <https://doi.org/10.21009/JTP.v21i1.12030>
- Septian, A., & Komala, E. (2019). Mathematical Connection Ability and Student Learning Motivation using Geogebra-Assisted Problem-Based Learning (PBL) Model in Junior High School. *PRISMA*, 8(1), 1–13. <https://doi.org/10.35194/jp.v8i1.438>
- Septian, A., Suwarman, R. F., Monariska, E., & Sugiarni, R. (2020). Somatic, Auditory, Visualization, Intellectually Learning Assisted by Geogebra to Improve Student's Mathematical Representation Skills. *Journal of Physics: Conference Series*, 1657(1), 012023. <https://doi.org/10.1088/1742-6596/1657/1/012023>
- Setiawan, R. (2020). Penggunaan Game Edukatif Berbantuan Wordwall dalam Meningkatkan Literasi Matematika Siswa Kelas V pada Materi Pecahan. *Jurnal Inovasi Pembelajaran Dasar*, 4(2), 55–67. <https://doi.org/10.26877/jipd.v4i2.7823>
- Stacey, K. (2011). The PISA View of Mathematical Literacy in Indonesia. *Indonesian Mathematical Society Journal on Mathematics Education*, 2(2), 95–126. <https://doi.org/10.22342/jme.2.2.746.95-126>

- Sugiyono. (2019). *Metode Penelitian Pendidikan: Pendekatan Kuantitatif, Kualitatif, dan R&D (Edisi Ke-3)*. Alfabeta.
- Sulisworo, D., & Yulianti, E. (2019). Penggunaan Media Pembelajaran Berbasis Teknologi untuk Meningkatkan Pemahaman Konsep Matematika di Sekolah Dasar. *Jurnal Riset Teknologi dan Inovasi Pendidikan*, 2(1), 11–22. <https://doi.org/10.36665/juteks.v2i1.112>
- Tokac, U., Novak, E., & Thompson, C. G. (2019). Effects of Game-Based Learning on Students' Mathematics Achievement: A Meta-Analysis. *Journal of Computer Assisted Learning*, 35(3), 407–420. <https://doi.org/10.1111/jcal.12347>
- Wahyu Ningtia, R., & Rahmawati, I. (2022). Pengembangan Media Wordwall pada Materi Kesetaraan Pecahan Mata Uang untuk Siswa Kelas II SDN. *Jurnal Didaktika Pendidikan Dasar*, 6(1), 159–170. <https://doi.org/10.26811/didaktika.v6i1.498>
- Windiyan, T., & Jaenudin, D. (2018). Pemanfaatan Media Pembelajaran Berbantuan Teknologi Interaktif dalam Pembelajaran Matematika di Sekolah Dasar. *Jurnal Pendidikan Dasar Universitas Pakuan*, 4(1), 12–24. <https://doi.org/10.33751/jpdas.v4i1.782>
- Windiyan, T., & Jaenudin, D. (2019). Penggunaan Game Edukatif Berbantuan Teknologi Digital untuk Meningkatkan Motivasi dan Pemahaman Materi Pecahan. *Jurnal Inovasi Pendidikan*, 3(2), 44–55. <https://doi.org/10.21831/jip.v3i2.6782>
- Yildirim, G., & Kiray, S. A. (2021). The Effects of Wordwall-Based Gamification on Mathematics Learning Motivation and Achievement. *Turkish Online Journal of Educational Technology*, 20(2), 52–64. <https://doi.org/10.17051/ilkonline.2021.02.06>
- Zhang, D., & Lin, X. (2020). Relational Understanding of Fractions and Decimal Numbers. *ZDM Mathematics Education*, 52(4), 801–816. <https://doi.org/10.1007/s11858-020-01134-4>