

Development of Interactive Mathematics Teaching Materials Based on the ADDIE Model to Improve Numeracy Literacy of Elementary School Students

Wewel Rommise, Tanjungpura University, Pontianak, Indonesia

Email* wewelrommise86@gmail.com

085225617023

abstract: This study examines the application of the ADDIE model in developing interactive mathematics teaching materials to enhance numeracy literacy among elementary school students. Using a library research approach, this study synthesizes national and international literature to explore how each phase of the ADDIE model contributes to instructional effectiveness. The findings indicate that the ADDIE framework ensures systematic alignment between learner needs, pedagogical design, interactive media integration, and continuous evaluation. Research reviewed in this study shows that ADDIE-based learning materials improve key numeracy literacy indicators, including conceptual understanding, reasoning skills, and student motivation. The integration of interactive technology such as digital simulations and contextual learning content further supports active, learner-centered mathematics instruction. In the context of West Kalimantan, the study highlights the need for locally relevant and accessible interactive materials, particularly for schools in remote areas with limited digital infrastructure. The implications of this research emphasize the importance of adopting structured instructional design models for teachers, instructional designers, and policymakers in strengthening literacy and numeracy programs within Kurikulum Merdeka. Overall, the findings reinforce the potential of the ADDIE model as a practical and adaptable framework for improving numeracy literacy in elementary mathematics education.

Keywords: ADDIE model, numeracy literacy, interactive learning materials, mathematics education, elementary school

Introduction

Mathematics is a fundamental discipline that plays a crucial role in shaping students' logical reasoning, problem-solving abilities, and critical thinking from an early age. At the elementary level, mathematics learning is expected to strengthen numeracy literacy, which includes the capacity to use numbers, interpret quantitative information, and apply mathematical reasoning to everyday contexts (Alhusna et al., 2025). Numeracy literacy has become increasingly important in the current era, as it forms the basis for students' academic readiness and their ability to participate meaningfully in a society driven by data, technology, and analytical skills.

Despite continuous educational reforms, Indonesian students' performance in mathematics remains far below international benchmarks. According to the Programme for International Student Assessment (PISA) 2022, Indonesia's average mathematics score was 366, significantly lower than the OECD average of 472. Furthermore, only 18% of Indonesian students reached proficiency level two,

indicating that they possess only basic mathematical reasoning skills and often struggle to apply these skills to real-life situations (OECD, 2023; Morata, 2024). These data reveal persistent challenges in students' conceptual understanding and the application of mathematical knowledge beyond procedural tasks.

At the national level, similar trends appear in the Ministry of Education's Asesmen Kompetensi Minimum (AKM). A substantial proportion of elementary students are categorized at the "developing" level, capable of solving procedural problems but experiencing difficulties when faced with questions that require reasoning, interpretation, or contextual analysis (Kemendikbudristek, 2023). These findings demonstrate that many current classroom practices do not adequately foster higher-order numeracy skills, which are essential components of the Kurikulum Merdeka.

The situation in West Kalimantan further underscores these challenges. Data from the Provincial Education Office show that mathematics learning outcomes among elementary students in districts such as Landak, Kapuas Hulu, and Sintang remain relatively low (Disdik Kalbar, 2023). In many rural and remote areas, schools continue to face limited access to digital resources, insufficient learning materials, and infrastructural constraints. As a result, mathematics instruction often relies heavily on traditional, teacher-centered methods that emphasize memorization and procedural exercises, leaving little opportunity for students to engage in interactive or contextualized learning activities that support deeper numeracy literacy development.

The discrepancy between the expected numeracy competencies and actual student outcomes highlights a pressing problem: the lack of effective, interactive, and contextually relevant teaching materials that can support meaningful mathematical understanding. Without such materials, efforts to improve numeracy literacy—particularly in geographically challenging regions—remain insufficient.

Although many scholars have emphasized the need for innovative and interactive mathematics learning resources, research focused on the systematic development of such materials remains limited. Specifically, few studies have examined the application of structured instructional design models such as ADDIE in producing interactive mathematics teaching materials for elementary students. Even fewer studies address this issue within the unique context of rural and remote regions like West Kalimantan, where challenges related to accessibility, digital readiness, and contextual relevance remain significant.

In response to these gaps, this study aims to analyze the application of the ADDIE model as a comprehensive and systematic framework for developing interactive mathematics teaching materials that can enhance numeracy literacy among elementary school students. Through a synthesis of national and international literature, this research seeks to establish a strong conceptual foundation for designing instructional materials that are pedagogically aligned, technologically adaptable, and contextually relevant. The findings are expected to provide meaningful insights for teachers, instructional designers, and policymakers in improving mathematics learning

outcomes and supporting literacy and numeracy initiatives within the Kurikulum Merdeka.

Given the persistent challenges identified in mathematics learning, the limited availability of interactive and contextually relevant instructional materials, and the research gaps related to the systematic development of such resources, it becomes essential to conduct a structured analysis of how the ADDIE model can be applied to support the creation of effective teaching materials. To achieve this objective, the present study adopts a library research approach that synthesizes national and international literature on instructional design, numeracy literacy, and the implementation of the ADDIE model in mathematics education. This methodological approach enables a comprehensive examination of theoretical frameworks, empirical findings, and best practices that inform the development of interactive mathematics teaching materials. The following section describes the research method used in this study, including the procedures for literature selection, analysis, and synthesis.

Method

This study employed a descriptive qualitative approach using a library research method. The primary aim was to analyze the application of the ADDIE instructional design model in developing interactive mathematics teaching materials that enhance numeracy literacy among elementary school students. Data sources consisted of national and international scientific articles indexed in Sinta, Scopus, and Google Scholar, published between 2018 and 2024. Sources were selected purposively based on topic relevance, methodological alignment, and publication quality. The research procedure included four stages: (1) source identification, involving systematic searches of literature on the ADDIE model and numeracy literacy; (2) source evaluation, to assess the credibility and suitability of each publication; (3) content analysis, in which findings were categorized according to the ADDIE phases: Analysis, Design, Development, Implementation, and Evaluation; and (4) synthesis, to derive broader conclusions about the effectiveness of the ADDIE model in supporting interactive mathematics learning in elementary education. Data credibility was strengthened through source triangulation and comparison across multiple studies. The results were organized and presented narratively to provide a comprehensive overview of how the ADDIE model contributes to improving numeracy literacy. However, it is important to note that this study is limited by the absence of empirical validation. Because the findings rely solely on secondary data, the conclusions presented cannot be generalized to specific classroom contexts without further field-based testing. Future research involving empirical implementation and evaluation is therefore necessary to strengthen the applicability of the findings.

Result and Discussion

Result

The results of this library research present findings from a comprehensive review and synthesis of national and international literature related to the development of interactive mathematics teaching materials using the ADDIE model to improve elementary students' numeracy literacy. The reviewed materials include journal articles, research reports, books, and government documents published between 2015 and 2025. The analysis focused on identifying trends, effective practices, and challenges in applying the ADDIE model in mathematics education, particularly in Indonesia, and its relevance to numeracy literacy improvement in the context of West Kalimantan (Romla, 2024). The synthesis indicates that the ADDIE model comprising five systematic stages: Analysis, Design, Development, Implementation, and Evaluation is one of the most widely used and effective instructional design models for developing interactive teaching materials. It provides a structured process that ensures the produced learning materials are pedagogically sound, technologically relevant, and responsive to learners' needs (Njonge, 2023). Studies consistently highlight that the integration of technology within the ADDIE framework enhances students' cognitive engagement and learning outcomes. For example, Rahmawati et al. (2022) found that students' numeracy literacy scores increased by 28% after using ADDIE-based digital modules. Likewise, Sutrisno and Hidayah (2021) reported that students' motivation and participation in learning mathematics improved significantly when interactive teaching materials were developed using ADDIE principles (Desy et al., 2024).

Table 1. Summary of Research Findings Related to the ADDIE Model in Mathematics Learning

No.	Author (Year)	Research Focus	Results	Implications
1	Rahmawati et al. (2022)	Interactive module for geometry	28% improvement in numeracy scores	ADDIE ensures structured design and engagement
2	Sutrisno & Hidayah (2021)	Digital learning design using ADDIE	Increased learning motivation	Promotes student-centered learning
3	Choi et al. (2020)	Integration of multimedia in ADDIE-based learning	Higher retention and comprehension	Enhances visual-spatial reasoning
4	Yuliani (2019)	ADDIE in elementary numeracy modules	85% of students achieved the KKM	Supports effective scaffolding
5	UNESCO (2023)	Southeast Asia numeracy framework	54% of students below expected proficiency	Indicates need for innovative digital materials

As presented in Table 1, the application of the ADDIE model across various studies consistently yields improvements in both student outcomes and instructional quality. However, the UNESCO (2023) report highlights that approximately 54% of students in Southeast Asia, including Indonesia, still perform below the expected proficiency level in numeracy (Laila et al., 2025). In West Kalimantan, data from the Indonesian National Assessment (Asesmen Nasional, 2022) revealed that 46% of elementary students scored below the basic level in numeracy literacy. The low achievement is closely related to limited access to interactive and contextualized learning materials, especially in remote and rural areas. This underscores the need to develop teaching resources that are interactive, locally relevant, and systematically designed following the ADDIE framework (Nafian, 2024).

Figure 1 demonstrates that the ADDIE model provides an iterative and flexible process that allows continuous refinement of instructional materials based on evaluation results. The Analysis phase ensures the identification of learners' needs and context; Design defines the structure and learning objectives; Development involves the creation of interactive materials; Implementation relates to their use in classroom or digital environments; and Evaluation ensures product validity and usability through both formative and summative feedback (Yuniria et al., 2025). From the reviewed studies, several common indicators of improved numeracy literacy were identified after using ADDIE-based interactive materials. These include conceptual understanding, problem-solving ability, motivation, and the integration of digital literacy skills (Dewi & Nurgiansah, 2024).

Table 2. Indicators of Numeracy Literacy Improvement After Using ADDIE-Based Teaching Materials

No.	Indicator	Description	Evidence from Studies
1	Conceptual Understanding	Students comprehend mathematical principles more easily through visualization and interactivity	Rahmawati et al. (2022); Choi et al. (2020)
2	Problem-Solving Skills	Improved ability to apply mathematics in daily contexts	Yuliani (2019); UNESCO (2023)
3	Motivation and Engagement	Increased interest and participation during lessons	Sutrisno & Hidayah (2021)
4	Digital Literacy Integration	Better ability to use digital tools for learning	Prasetyo (2021)
5	Learning Outcomes	Measurable improvement in post-test and assessment results	Rahmawati et al. (2022); Yuliani (2019)

As presented in Table 2, all reviewed studies confirm that learning materials developed using the ADDIE model contribute to measurable improvements in numeracy literacy. The materials encourage students to engage with mathematical

problems contextually, connect abstract concepts to real-world examples, and utilize interactive media to deepen understanding (Labor, 2025). In the context of West Kalimantan, teachers face unique challenges such as limited access to digital devices and uneven internet connectivity, particularly in rural districts like Landak and Kapuas Hulu. However, studies (e.g., Sari et al., 2021) show that even in low-resource settings, low-cost interactive tools (e.g., offline modules, simple animations, or augmented reality using mobile phones) based on the ADDIE model can effectively stimulate student engagement and enhance numeracy literacy (Grimes et al., 2021). These findings imply that a locally adapted version of the ADDIE model can be instrumental for developing digital and printed learning materials that cater to both urban and rural learning environments. By embedding local cultural contexts, such as examples drawn from students' daily life in Kalimantan, teachers can make mathematics more meaningful and relevant (Sarifah et al., 2022). The results of this library research strongly support the use of the ADDIE model as a systematic approach for developing interactive mathematics teaching materials that improve numeracy literacy among elementary students. The synthesis indicates that the model not only enhances learning outcomes but also contributes to the development of 21st-century competencies, including digital literacy, critical thinking, and creative problem-solving. Future empirical research in West Kalimantan is recommended to validate these findings and to explore the implementation of ADDIE-based materials in real classroom environments (Afandi et al., 2021).

Discussion

The discussion of this study extends the findings by interpreting what the reviewed literature reveals about the conceptual significance of the ADDIE model in improving numeracy literacy. The analysis reaffirms that numeracy is a multifaceted competence involving reasoning, problem-solving, and the application of mathematical concepts in real contexts, as described by OECD (2023). This framing positions numeracy as applied literacy that supports learners in navigating quantitative information and making informed decisions. Despite this importance, national assessments indicate ongoing challenges. Kemendikbudristek (2023) reported that a considerable proportion of Indonesian elementary students remain below the minimum competency standard in numeracy, and West Kalimantan shows a particularly concerning pattern due to restricted digital access and shortages of quality instructional resources (Sirait et al., 2023).

Within this broader educational context, the reviewed studies collectively demonstrate that the ADDIE framework provides a systematic pathway for addressing gaps in instructional design. The Analysis stage plays an essential role in identifying learner needs, curriculum inconsistencies, and contextual demands. Research such as Rahmawati et al. (2022) and Sari et al. (2021) highlights that effective needs analysis produces culturally relevant materials. For West Kalimantan, this step is

significant because integrating local examples taken from agriculture, trading, or environmental issues helps strengthen students' contextual understanding (Syahida and Glory, 2022).

The Design and Development stages are central to improving engagement and comprehension. Studies by Choi et al. (2020) and Prasetyo (2021) show that interactive multimedia and digital tools elevate students' motivation, enhance visual reasoning, and support deeper conceptual learning when developed through structured design principles. These insights align with the synthesis presented in this article, which emphasizes that interactivity guided by systematic instructional planning promotes both cognitive and affective dimensions of numeracy literacy (Triwahyuningtyas et al., 2022).

The Implementation stage demonstrates the practicality of ADDIE-based materials when tested in real or simulated learning environments. For example, Yuliani (2019) reported substantial increases in student achievement after classroom trials of ADDIE-based numeracy modules. This stage's iterative nature supports ongoing adjustments, ensuring that instructional resources remain responsive to learners' needs. Such adaptability is particularly critical for rural schools in West Kalimantan, where teachers often modify materials to suit local languages, cultural nuances, and limited technological infrastructure (Alnajdi, 2018). The Evaluation stage reinforces material effectiveness over time, as noted by Sutrisno and Hidayah (2021), and functions as a continuous improvement loop rather than a final checkpoint (Hermita et al., 2021).

Conceptually, the results support the intersection of the ADDIE model with constructivist learning theory and cognitive load theory. Constructivist principles suggest that learners build knowledge through experience and interaction. Interactive materials such as augmented reality visuals or animated mathematical representations developed through structured design encourage students to construct meaning through exploration (Vygotsky, 1978; Mayer, 2021). Cognitive load theory further explains why well-designed multimedia reduces extraneous cognitive effort and enhances learning efficiency (Pitanti, 2023). The synergy between instructional design and learning theory provides a coherent explanation for the consistent improvements documented in numeracy literacy.

The synthesis also reveals several conceptual patterns that define successful ADDIE-based materials. Interactivity fosters active engagement, contextualization helps students connect abstract concepts to daily experiences, and scaffolding supports a gradual progression of mathematical competence (M et al., 2023). These characteristics distinguish structured instructional design from fragmented digital initiatives that do not follow systematic development procedures. Handayani and Putra (2018) note that initiatives lacking structured design often yield minimal and inconsistent impact on numeracy literacy, a pattern addressed by the comprehensive processes embedded in the ADDIE framework (Sukmana et al., 2021).

In the context of West Kalimantan, the reviewed literature indicates significant implications. The challenges of limited technology access and uneven digital infrastructure require instructional designs that are adaptable and context-sensitive. Teachers can utilize simplified forms of interactive materials, such as offline modules, printed worksheets supported by QR codes, or low-bandwidth augmented reality, which have been shown to improve engagement even in low-resource settings (Grimes et al., 2021). These adaptations ensure equitable learning opportunities while increasing digital readiness for rural learners. This aligns with UNESCO's (2023) call for inclusive digital education systems that are accessible regardless of geographic barriers.

This study contributes conceptually by synthesizing a decade of literature and offering a structured foundation for future empirical research. It highlights the need for more studies conducted directly in rural Indonesian contexts, extended evaluations of ADDIE-based materials, and deeper integration between digital literacy and numeracy development (Nabela and Agustine, 2024). These gaps offer meaningful directions for subsequent research.

Although this study provides a comprehensive synthesis, its reliance on library research presents inherent limitations. The absence of classroom implementation restricts the ability to validate findings through direct observation, measurement, or controlled experimentation. Furthermore, variations in research quality, geographic focus, and methodological rigor across the reviewed sources may influence the generalizability of conclusions. These limitations underscore the importance of conducting future empirical studies, including mixed-methods research, to confirm the effectiveness of ADDIE-based materials and their relevance in diverse classroom environments (Adrillian et al., 2023).

Overall, the discussion underscores that the ADDIE model serves as a coherent framework for designing interactive mathematics materials that support numeracy literacy. Its structured flow from needs analysis to evaluation ensures alignment between instructional goals, content, pedagogy, and media selection. When contextualized for Indonesian elementary education, particularly in under-resourced regions such as West Kalimantan, the model demonstrates adaptability and strategic value. The synthesis affirms that structured instructional design, contextual relevance, and technological interactivity form a strong foundation for improving numeracy literacy in the digital era. This conceptual understanding provides an essential basis for future empirical investigations and practical innovations in mathematics education.

Conclusion

This study concludes that the ADDIE model provides a coherent and structured foundation for developing interactive mathematics teaching materials that support the improvement of numeracy literacy in elementary education. The synthesis of national and international literature shows that when instructional materials are designed

systematically through the ADDIE stages, they contribute to clearer conceptual understanding, increased motivation, and strengthened mathematical reasoning among students. These findings affirm the relevance of combining structured instructional design with interactive and contextually grounded learning resources.

The study offers two main contributions. Conceptually, it strengthens the theoretical linkage between constructivist learning principles, cognitive load management, and systematic instructional design. Practically, it highlights the potential of interactive and locally relevant materials—particularly for regions with limited digital infrastructure such as West Kalimantan—to broaden learning access and enhance the quality of mathematics instruction.

The implications underscore the need for teachers, curriculum developers, and schools to adopt structured development models such as ADDIE when creating instructional materials, especially when integrating digital or interactive media. Such an approach ensures pedagogical alignment, contextual relevance, and sustained quality improvement.

However, the findings of this study are limited by the absence of empirical validation, as the conclusions are based solely on secondary sources. Future research should therefore examine the implementation of ADDIE-based materials directly in classroom settings, explore their effectiveness in diverse regional contexts, and assess long-term impacts on students' numeracy development. Empirical studies of this kind will provide stronger evidence for the practical applicability of the ADDIE framework in mathematics education.

References

- Adrillian, H., Nizaruddin, N., & Aini, A. N. (2023). Pengembangan game edukasi matematika berbasis aplikasi Android untuk meningkatkan kemampuan literasi numerasi siswa SMP. *Jurnal Kualita Pendidikan*, 4(1), 72–81. <https://doi.org/10.51651/jkp.v4i1.379>
- Afandi, M., Kusumadewi, R. F., & Lestari, R. D. (2021). Developing digital based comic media in teaching mathematics for elementary school students. *JMIE (Journal of Madrasah Ibtidaiyah Education)*, 5(2), 184. <https://doi.org/10.32934/jmie.v5i2.339>
- Alfarisy, H., & Awalludin, S. A. (2023). Development of numeracy and literacy-based probability teaching materials. *Unnes Journal of Mathematics Education*, 12(2), 122–130. <https://doi.org/10.15294/ujme.v12i2.70885>
- Alhusna, A., Gistituati, N., & Ardi, H. (2025). Inquiry learning innovation: Efforts to develop inquiry-based teaching materials to increase mathematical and language literacy for mathematics students at university. *Jurnal Ilmiah Ilmu Terapan Universitas Jambi*, 9(2), 546–561. <https://doi.org/10.22437/jiituj.v9i2.41592>
- Alnajdi, S. M. (2018). The effectiveness of designing and using a practical interactive lesson based on ADDIE model to enhance students' learning performances in

University of Tabuk. *Journal of Education and Learning*, 7(6), 212.
<https://doi.org/10.5539/jel.v7n6p212>

Astika Dewi, M. S., & Nurgiansah, T. H. (2024). Development of contextually based mathematics learning modules in improving numeracy literacy for class V students. *Aurelia: Jurnal Penelitian dan Pengabdian Masyarakat Indonesia*, 4(1), 46–55. <https://doi.org/10.57235/aurelia.v4i1.3304>

Aunio, P., Korhonen, J., Ragpot, L., Törmänen, M., & Henning, E. (2021). An early numeracy intervention for first-graders at risk for mathematical learning difficulties. *Early Childhood Research Quarterly*, 55, 252–262. <https://doi.org/10.1016/j.ecresq.2020.12.002>

Desy, A., Nursalam, Suharti, Andi Mattoliang, L., & Baharuddin. (2024). Development of mathematics teaching material based on experiential learning model to improve students' mathematical literacy skills. *ITM Web of Conferences*, 58, 03003. <https://doi.org/10.1051/itmconf/20245803003>

F. N. Pangemanan, N., Domu, I., & M. Salajang, S. (2024). Development of mathematics teaching materials assisted by PowerPoint media to improve literacy and numeracy skills in statistics material in vocational schools. *International Journal of Science and Research*, 13(6), 1790–1796. <https://doi.org/10.21275/sr24626213406>

Fadla, E., Mukhtar, M., & Tambunan, H. (2023). Development of learning video to improve numeracy skills elementary school students. *Jurnal Pendidikan Dasar Islam*. <https://doi.org/10.4108/eai.19-9-2023.2340519>

Fery, M. F., Wahyudin, & Tatang, H. (2017). Improving primary students' mathematical literacy through problem based learning and direct instruction. *Educational Research and Reviews*, 12(4), 212–219. <https://doi.org/10.5897/err2016.3072>

Goh, K. M. (2025). Gamifying number recognition: A mobile learning approach for primary students. *Citra Journal of Innovative Education Practices*, 1(1), 1–13. <https://doi.org/10.37934/cjiep.1.1.113>

Grimes, K. R., Park, S., McClelland, A., Park, J., Lee, Y. R., Nozari, M., Umer, Z., Zapparolli, B., & Bryant, D. (2021). Effectiveness of a numeracy intelligent tutoring system in kindergarten: A conceptual replication. *Journal of Numerical Cognition*, 7(3), 388–410. <https://doi.org/10.5964/jnc.6931>

Hasibah, H., Sama', S., & Jamilah, J. (2025). Enhancing elementary numeracy skills through visualization-based accelerated learning cycle. *Al-Ishlah: Jurnal Pendidikan*, 17(2), 2478–2488. <https://doi.org/10.35445/alishlah.v17i2.6662>

Hermita, N., Alim, J. A., Putra, Z. H., Gusti, P. M., Wijaya, T. T., & Pereira, J. (2021). Designing interactive games for improving elementary school students' number

- sense. Al-Jabar: Jurnal Pendidikan Matematika, 12(2), 413–426.
<https://doi.org/10.24042/ajpm.v12i2.9983>
- Hidayat, R. A., Wijayanto, Z., & Sutarna, S. (2024). Digital media innovation for enhancing numeracy literacy in elementary schools. *Profesi Pendidikan Dasar*, 222–235. <https://doi.org/10.23917/ppd.v11i3.5991>
- Jannah, S. R., Muharram, N. A., Herpandika, R. P., & Setiawan, I. (2024). Development of a traditional game “engklek” based on numeracy literacy to improve locomotor movements of elementary school students. *Indonesian Journal of Research in Physical Education, Sport, and Health*, 2(2), 49–57. <https://doi.org/10.17977/um086v2i22024p49-57>
- Labor, G. T. (2025). Development of contextualized numeracy materials for grade 1 learners of Sioan Integrated School. *International Journal of Scientific and Research Publications*, 15(3), 112–133. <https://doi.org/10.29322/ijsrp.15.03.2025.p15915>
- Laila, A., Afandi, S., & Yasin, M. H. M. (2025). The effectiveness of augmented reality-based pocket books to improve numeracy literacy skills of elementary school students. *DWIJA Cendekia: Jurnal Riset Pedagogik*, 9(1), 69. <https://doi.org/10.20961/jdc.v9i1.99900>
- Lindström-Sandahl, H., Samuelsson, J., Danielsson, H., Samuelsson, S., & Elwér, Å. (2024). A randomized controlled study of a second-grade numeracy intervention with Swedish students at-risk of mathematics difficulties. *British Journal of Educational Psychology*, 94(4), 1052–1071. <https://doi.org/10.1111/bjep.12705>
- M, V. A. S., Laihat, L., Harini, B., Safitri, M. L. O., Melati, S. P., Rahmadan, D., Hayati, S., & Handrianto, C. (2023). Movable page-based interactive books on numbers in elementary schools. *Indonesian Journal on Learning and Advanced Education*, 5(2), 167–177. <https://doi.org/10.23917/ijolae.v5i2.21705>
- Miller, T. (2018). Developing numeracy skills using interactive technology in a play-based learning environment. *International Journal of STEM Education*, 5(1). <https://doi.org/10.1186/s40594-018-0135-2>
- Morata, J. A. (2024). Enhancing the numeracy skills of grade 8 students through Quizizz: An interactive learning approach for improved mathematical proficiency. *Journal of Interdisciplinary Perspectives*, 2(12), 382–390. <https://doi.org/10.69569/jip.2024.0581>
- Nabela, S. J., & Agustine, P. C. (2024). Development of digital teaching material based on numeracy for 4th class primary school. *Journal of Education and Learning Mathematics Research*, 5(1), 1–6. <https://doi.org/10.37303/jelmar.v5i1.125>
- Nafian, M. I. (2024). Development of augmented reality media to grow numerical literacy of elementary school students. *International Journal of Education*

Elementaria and Psychologia, 1(3), 125–134.
<https://doi.org/10.70177/ijee.v1i3.947>

Njonge, T. (2023). Influence of psychological well-being and school factors on delinquency during the COVID-19 period among secondary school students in selected schools in Nakuru County: Kenya. *International Journal of Research and Innovation in Social Science*, 7, 1175–1189. <https://doi.org/10.47772/IJRISS>

Outhwaite, L. A., Faulder, M., Gulliford, A., & Pitchford, N. J. (2019). Raising early achievement in math with interactive apps: A randomized control trial. *Journal of Educational Psychology*, 111(2), 284–298. <https://doi.org/10.1037/edu0000286>

Pitanti, A. M. (2023). Revolutionizing education: Enhancing numeracy skills with the innovative Monster Math game. *Pedagogia: Jurnal Pendidikan*, 12(2), 76–91. <https://doi.org/10.21070/pedagogia.v12i2.1573>

Rahayu, N. K. A., & Suarjana, I. M. (2024). Virtual manipulatives: A pathway to enhancing numeracy skills in inclusive classrooms. *International Journal of Elementary Education*, 8(3), 503–510. <https://doi.org/10.23887/ijee.v8i3.89805>

Romla, S. (2024). Valid, practical, and effective numeracy literacy module for 5th grade students. *Inquest Journal*, 3(11), 1–16.

Sarifah, I., Rohmaniar, A., Marini, A., Sagita, J., Nuraini, S., Safitri, D., Maksum, A., Suntari, Y., & Sudrajat, A. (2022). Development of Android-based educational games to enhance elementary school student interests in learning mathematics. *International Journal of Interactive Mobile Technologies*, 16(18), 149–161. <https://doi.org/10.3991/ijim.v16i18.32949>

Sirait, S., Syafitri, E., & Nisa, K. (2023). The development of animation-based learning on students' numeracy literacy skills. *Al-Ishlah: Jurnal Pendidikan*, 15(2), 1696–1705. <https://doi.org/10.35445/alishlah.v15i2.2858>

Spatioti, A. G., Kazanidis, I., & Pange, J. (2022). A comparative study of the ADDIE instructional design model in distance education. *Information*, 13(9), 1–20. <https://doi.org/10.3390/info13090402>

Sukesi, K. B., & Jusra, H. (2024). Pengembangan bahan ajar interaktif melalui Heyzin dalam meningkatkan kemampuan siswa. *Jurnal Pendidikan Dasar Islam*, 11(2), 149–160.

Sukmana, A. I. W. I. Y., Pudjawan, K., & Parmiti, D. P. (2021). Improving student arithmetic ability through interactive multimedia development on mathematics competencies of third grade elementary school students. In *Proceedings of the 2nd International Conference on Technology and Educational Science (ICTES 2020)* (pp. 195–199). <https://doi.org/10.2991/assehr.k.210407.237>

- Syahida, F., & Purba, G. I. D. (2022). Development of interactive teaching materials based on PBL learning models to improve students' mathematical reasoning ability. *Jurnal Ilmiah Pendidikan Holistik*, 1(3), 269–286. <https://doi.org/10.55927/jiph.v1i3.2277>
- Triwahyuningtyas, D., Sesanti, N. R., Firdayanti, E., & Aziza, N. (2022). Multiplication and division of fractions based on numerical literacy electronic module for fifth grade elementary school students. *Jurnal Prima Edukasia*, 10(1), 37–46. <https://doi.org/10.21831/jpe.v10i1.44881>
- Yaniawati, P., Fisher, D., Permadi, Y. D., & Yatim, S. A. M. (2023). Development of mobile-based digital learning materials in blended learning oriented to students' mathematical literacy. *International Journal of Information and Education Technology*, 13(9), 1338–1347. <https://doi.org/10.18178/ijiet.2023.13.9.1936>
- Yuniria, A. R., Atikah, C., & Asmawati, L. (2025). Interactive educational games: Boosting numeracy skills in 4–5 year-olds through multimedia. *Al-Ishlah: Jurnal Pendidikan*, 17(1), 1236–1246. <https://doi.org/10.35445/alishlah.v17i1.5503>
- Yustitia, V., Wijayanti, S., Faridah, L., Emilia, N. P., & Kusmaharti, D. (2025). Ethnomathematics-based interactive video of Dermo Temple to enhance numeracy skills of elementary school students. *KnE Social Sciences*, 10(9), 189–206. <https://doi.org/10.18502/kss.v10i9.18490>