

Needs Analysis for the Development of an Ethnopedagogy-Based Educational Game in Elementary School Mathematics Learning

Ratih Widuri^{a,1,*}, Syarifuddin^{b,2}, Erna Retna Safitri^{c,3}

^{a,b,c}Department of Educational Technology, Faculty of Teacher Training and Education, Universitas Sriwijaya, Palembang, Indonesia

¹ratihwiduri01@gmail.com

²Syarifuddin@fkip.unsri.ac.id

³ernaretnasafitri@fkip.unsri.ac.id

*Corresponding Author

ARTICLE HISTORY

Received:

September 29, 2026

Revised:

October 14, 2026

Published:

October 31, 2026

Keywords:

Needs Analysis;
Educational Game;
Ethnopedagogy;
Mathematics
Learning;
Elementary School;
Interactive Flat Panel

ABSTRACT

This study aims to analyze the needs for developing an ethnopedagogy-based educational game for elementary school mathematics learning as a foundation for creating interactive, technology-based learning media. Mathematics learning faces challenges related to abstract concepts, limited student engagement, and insufficient contextual and attractive learning media. This study employed a quantitative descriptive approach at the analysis stage of the ADDIE development model (Analysis, Design, Development, Implementation, Evaluation). Participants comprised 62 fifth-grade elementary school students and 10 teachers selected through purposive sampling. Data were collected using needs analysis questionnaires covering interactive mathematics learning, technology utilization, educational game characteristics, challenges and feedback, local cultural integration, and Interactive Flat Panel (IFP) technology. Data were analyzed using descriptive statistics, including means, standard deviations, frequencies, and percentages. The results indicated that teachers demonstrated a high need for the proposed educational game, with an average score of 99.40, equivalent to 99.40% of the ideal score. Students obtained an average score of 139.61, representing 93.08% of the ideal score, while 85.48% were categorized as needing the proposed media. These findings highlight the importance of developing ethnopedagogy-based educational games supported by interactive technology to create more engaging, contextual, and developmentally appropriate mathematics learning experiences for elementary school students.

Copyright © 2026 (Ratih Widuri, Syarifuddin, Erna Retna Safitri). All Right Reserved

Widuri, Ratih., Syarifuddin, & Safitri, E. R. (2026). Needs Analysis for the Development of an Ethnopedagogy-Based Educational Game in Elementary School Mathematics Learning. *Pi: Mathematics Education Journal*, 9(2), 11-21. <https://doi.org/10.21067/pmej.v9i2.14946>



This work is licensed under a [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/). Allows readers to read, download, copy, distribute, print, search, or link to the full texts of its articles and allow readers to use them for any other lawful purpose. The journal hold the copyright.

1. Introduction

Mathematics learning in elementary schools requires learning experiences that enable students to understand concepts through meaningful, contextual, and interactive



<https://doi.org/10.21067/pmej.v9i2.14946>

email: pi@unikama.ac.id

activities. However, many mathematical concepts remain abstract for elementary students, particularly when learning is dominated by symbolic representations and teacher-centered explanations. These conditions may create difficulties for students in constructing mathematical understanding because they require visual, concrete, and contextual learning experiences that are aligned with their cognitive development. Therefore, fifth-grade students need learning media that not only support conceptual understanding but also provide opportunities to connect mathematical concepts with their surrounding environment and cultural experiences.

Interactive learning media can support students in understanding abstract mathematical concepts through visual, concrete, and easily understandable representations (Mayer, 2020). The use of interactive media also provides opportunities for students to engage actively through exploration, visualization, and direct interaction with learning materials. In this context, mathematics learning media should not only focus on technological aspects but also consider contextual elements that are close to students' daily lives. Integrating cultural contexts into mathematics learning can make learning experiences more meaningful because students are able to relate mathematical concepts to their social and cultural environments.

However, mathematics learning in elementary schools still faces several challenges. Students often experience difficulties in understanding mathematical concepts when learning activities rely mainly on textbooks, verbal explanations, and conventional exercises with limited use of interactive learning media. These conditions may influence students' motivation, engagement, and interest in mathematics. Although digital technology has become increasingly familiar in students' lives, its utilization as an interactive and contextual learning resource in elementary mathematics classrooms remains limited.

One potential solution to address these challenges is the development of educational games in mathematics learning. Educational games provide learning experiences through challenges, exploration, feedback, and interaction, which can increase students' motivation and engagement. Previous studies have demonstrated that digital game-based learning contributes positively to mathematics learning by supporting conceptual understanding, problem-solving abilities, and active student involvement. Systematic reviews have shown that digital games in elementary mathematics learning provide cognitive and affective benefits because they combine visualization, interaction, and active learning experiences (Hsu et al., 2026). Similarly, Yulianto et al. (2025) reported that digital game-based mathematics learning improves learning outcomes through the integration of challenges, feedback, interaction, and visualization of mathematical concepts. Furthermore, Apriani et al. (2025) found that educational games in elementary mathematics classrooms can create more engaging learning environments and increase student participation.

Although previous studies have highlighted the effectiveness of educational games in mathematics learning, several limitations remain. Existing educational game developments have primarily emphasized game mechanics, visualization, and interactive activities, while the integration of local cultural contexts as part of mathematics learning experiences has received less attention. In addition, previous studies have not sufficiently explored the combination of ethnopedagogical approaches and Interactive Flat Panel (IFP) technology to develop mathematics learning media that are both culturally relevant and technologically interactive for elementary school students. The use of IFP provides potential advantages through touch-based interaction, multimedia presentation, and collaborative classroom activities; however, its integration with ethnopedagogy-based educational games remains an area that requires further investigation.

Therefore, before developing such learning media, a needs analysis is necessary to identify the expectations, characteristics, and requirements of potential users. Needs analysis

is an essential stage in development research because it identifies the gap between existing learning conditions and the characteristics of the learning products required by users. Teachers require media that are practical, aligned with learning objectives, and capable of supporting mathematics instruction, while students require learning media that are attractive, interactive, contextual, and suitable for their learning characteristics. Effective educational technology development needs to consider user needs, usability, and learning experiences to ensure that the developed product can be accepted and optimally utilized (Kemp et al., 2024).

Based on these considerations, this study focuses on analyzing the needs for developing an ethnopedagogy-based educational game supported by Interactive Flat Panel technology in fifth-grade elementary school mathematics learning. This study aims to answer the following research questions: (1) What is the level of teacher needs for the development of ethnopedagogy-based educational games in elementary school mathematics learning? and (2) What is the level of student needs for the development of ethnopedagogy-based educational games in fifth-grade elementary school mathematics learning?

The results of this study are expected to provide empirical information regarding the characteristics of learning media required by teachers and students. Furthermore, the findings serve as a foundation for developing interactive, contextual, and technology-based mathematics learning media that integrate educational games, ethnopedagogical approaches, and Interactive Flat Panel technology according to the characteristics of elementary school students.

2. Methods

This study employed a quantitative approach with a descriptive method aimed at identifying the level of teacher and student needs for the development of ethnopedagogy-based educational games in elementary school mathematics learning. This research represented the analysis stage of the ADDIE development model (Analysis, Design, Development, Implementation, Evaluation), which aims to obtain initial information regarding user characteristics, learning needs, and learning problems as the basis for developing product specifications (Branch, 2009; Sugiyono, 2022).

The research data were collected through needs analysis questionnaires distributed to teachers as learning media users and fifth-grade elementary school students as potential users of the educational game being developed. In addition to the questionnaire, this study also employed semi-structured interviews with teachers as supporting data. The interviews were conducted to obtain more in-depth information regarding mathematics learning conditions, students' learning difficulties, the use of learning media, the need for interactive learning media, the utilization of educational technology, and opportunities for integrating local cultural elements into mathematics learning.

The interview data were analyzed descriptively to strengthen the findings obtained from the questionnaire-based needs analysis. The results of the interviews were used as supporting evidence to provide a more comprehensive understanding of teacher and student needs related to the development of ethnopedagogy-based educational games. The research participants were selected using purposive sampling based on specific considerations aligned with the research objectives. The participant criteria included elementary school teachers and students who were involved in mathematics learning activities and had experience using learning media.

The participants consisted of 62 fifth-grade elementary school students and 10 elementary school teachers. Students were selected as potential users because they represent the main target users of the ethnopedagogy-based educational game supported by Interactive Flat Panel (IFP) technology. Meanwhile, teachers were selected as supporting users because they have experience in planning and implementing mathematics learning and understand the needs for learning media that can support classroom instruction.

The research instruments consisted of needs analysis questionnaires and teacher interview guidelines. The student needs analysis questionnaire consisted of 15 statement items, while the teacher needs analysis questionnaire consisted of 10 statement items. Each questionnaire item was measured using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The questionnaire indicators covered several aspects, including the need for interactive mathematics learning, the use of technology in learning, characteristics of educational games, challenge and feedback elements, integration of local cultural contexts, and the need for Interactive Flat Panel technology as a supporting learning medium.

Before being used for data collection, the instruments underwent an expert validation process to ensure the suitability of the items with the research objectives. The validation process assessed several aspects, including item relevance, language clarity, and the representation of indicators related to the needs for developing ethnopedagogy-based educational games. The validated instruments were revised according to expert suggestions before being distributed to teachers and students. Furthermore, reliability analysis was conducted to determine the internal consistency of the questionnaire instruments.

The questionnaire data were analyzed using descriptive statistics, including total scores, percentage scores, frequencies, and percentages. The level of need was determined based on the percentage of the obtained score compared with the ideal score. The percentage of the ideal score was calculated by comparing the total empirical score obtained from respondents with the maximum possible score based on the number of respondents, questionnaire items, and the five-point Likert scale used. Therefore, the reported results represent the percentage of the ideal score, rather than the individual mean score of respondents.

Meanwhile, interview data were analyzed descriptively through data reduction, data presentation, and conclusion drawing processes. The interview results served as triangulation data to support the interpretation of teacher and student needs analysis findings. The results of the needs analysis were subsequently used as the basis for determining the characteristics of the product to be developed, including game design, mathematics content, integration of local cultural elements, interaction patterns, and technology features appropriate to user needs.

3. Result and Discussion

Result

Teachers' and Students' Needs for the Development of Educational Game-Based Mathematics Learning Media

Teachers' Needs for the Development of Ethnopedagogy-Based Educational Games

The results of the needs analysis conducted among teachers indicated a very high level of need for the development of ethnopedagogy-based educational games supported by Interactive Flat Panel (IFP) technology in elementary school mathematics learning. Based on the responses of 10 teachers, the overall percentage of need reached 99.40% of the ideal score. This percentage was obtained by comparing the obtained responses with the ideal score of the instrument. The calculation of the ideal score was based on the number of questionnaire items and the maximum score of the five-point Likert scale used in the instrument.

The categorization of teacher needs was determined based on the percentage of the obtained score compared with the ideal score. Respondents who achieved the maximum percentage score were categorized as "needing" the developed media, while respondents who obtained scores below the maximum percentage were categorized as "not needing" the developed media. Based on this categorization, 9 teachers (90%) were classified as needing

the development of ethnopedagogy-based educational games, while 1 teacher (10%) was categorized as not needing the developed media.

The analysis of each aspect showed that the mathematics learning condition aspect obtained a percentage of 100%, the students' learning difficulties aspect obtained 100%, the learning media utilization aspect obtained 97%, the learning media needs aspect obtained 100%, the technology utilization aspect obtained 100%, and the ethnopedagogical integration aspect obtained 100%. These findings indicate that teachers strongly require mathematics learning media that are more interactive, contextual, and appropriate to the characteristics of elementary school students.

The high percentage obtained in each aspect indicates that teachers perceive the importance of developing learning media that can support more meaningful mathematics learning experiences. Teachers require media that not only assist in explaining abstract mathematical concepts but also provide opportunities for interaction, exploration, and the integration of contextual learning experiences. Furthermore, the high percentage in the technology utilization and ethnopedagogical integration aspects demonstrates that teachers recognize the potential of combining digital technology and local cultural contexts in mathematics learning.

The distribution of teachers' needs percentages based on each aspect for the development of ethnopedagogy-based educational games using Interactive Flat Panel technology is presented in Figure 1.

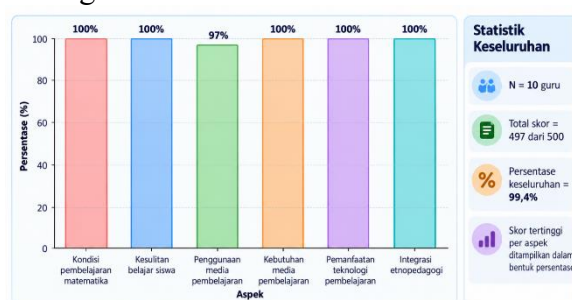


Figure 1. Distribution of Needs Scores Based on Teacher Responses

Based on Figure 1, the percentage analysis of teachers' needs shows that all aspects assessed were in the very high category. The overall percentage of teacher needs reached 99.40%, indicating that teachers strongly require the development of ethnopedagogy-based educational games supported by Interactive Flat Panel (IFP) technology for elementary school mathematics learning. The aspect analysis showed that the mathematics learning condition, students' learning difficulties, learning media needs, technology utilization, and ethnopedagogical integration aspects each obtained a percentage of 100%, while the learning media utilization aspect obtained 97%. These findings indicate that teachers perceive the need for learning media that can support more interactive, contextual, and meaningful mathematics learning experiences.

The high percentage in the mathematics learning condition and students' learning difficulties aspects indicates that teachers recognize the challenges in delivering mathematical concepts, particularly concepts that require visual representation and concrete learning experiences. Therefore, teachers require learning media that can assist them in presenting abstract mathematical concepts in a more understandable form. The high percentage in the learning media needs aspect also demonstrates that teachers need innovative media that can increase student engagement, provide varied learning activities, and support more effective mathematics instruction.

Furthermore, the 100% percentage obtained in the technology utilization aspect indicates that teachers recognize the importance of integrating digital technology into mathematics learning. Interactive Flat Panel technology provides opportunities for teachers

to present learning materials through visual displays, multimedia elements, and interactive activities that encourage student participation. Through this technology, mathematics learning can be presented in a more engaging and student-centered manner.

The ethnopedagogical integration aspect also obtained a percentage of 100%, showing that teachers consider local cultural contexts as an important element in the development of mathematics learning media. The integration of cultural elements into educational games allows mathematical concepts to be connected with students' daily experiences and surrounding environments. This approach can help students understand mathematics not only as abstract knowledge but also as concepts that are related to their cultural and social contexts.

The findings related to the need for game-based learning also indicate that teachers require media that provide opportunities for exploration, challenges, interaction, and feedback. Educational games can support more active mathematics learning experiences by involving students in meaningful problem-solving activities (Nguyen et al., 2024). Therefore, the development of ethnopedagogy-based educational games using Interactive Flat Panel technology needs to consider several important components, including interactivity, game design, mathematical content suitability, cultural integration, usability, and the developmental characteristics of elementary school students.

Teachers' Interview Findings

In addition to quantitative questionnaire results, teacher interview data provided findings that supported the need for developing ethnopedagogy-based educational games in mathematics learning. Based on the interview results, teachers explained that mathematics learning in elementary schools still faces challenges, particularly in explaining abstract concepts. Students tend to experience difficulties when mathematical materials are delivered only through verbal explanations and exercises without support from concrete and interactive learning media.

Teachers also stated that the learning media currently available are still limited, mainly consisting of textbooks, pictures, and simple instructional media that have not fully encouraged active student involvement in the learning process. Therefore, innovative media are needed to provide more engaging learning activities through visual elements, games, and direct interaction. Educational games are considered an alternative solution because they can provide learning experiences through challenges, exploration, and feedback that are appropriate to the characteristics of elementary school students.

The interview results also showed that teachers had positive perceptions regarding the use of Interactive Flat Panel (IFP) technology in mathematics learning. According to teachers, interactive devices can support more varied presentations of learning materials and provide opportunities for students to participate directly in classroom activities. However, teachers emphasized that the developed media should have a user-friendly design, align with learning objectives, and not merely emphasize technological features but also provide strong pedagogical value.

Furthermore, teachers stated that integrating local cultural elements into mathematics learning has the potential to increase meaningful learning experiences. Mathematical concepts connected to students' surrounding environment and culture are considered easier to understand because students can recognize the relationship between learning materials and their daily experiences. These interview findings strengthen the questionnaire results, indicating that teachers require mathematics learning media that are interactive, contextual, and capable of integrating technology and local cultural elements through ethnopedagogy-based educational games.

Students' Needs for the Development of Educational Game-Based Mathematics Learning Media

The results of the student needs analysis indicated a very high level of need for the development of ethnopedagogy-based educational games supported by Interactive Flat Panel (IFP) technology in elementary school mathematics learning. Based on the responses of 62 students, the overall percentage of need reached 93.08% of the ideal score. This finding indicates that students showed a strong need for mathematics learning media that are interactive, interesting, and relevant to their learning characteristics. Based on the categorization results, 53 students (85.48%) were classified as needing the developed media, while 9 students (14.52%) were categorized as not needing the media. These findings show that the majority of students require innovative learning media that can support more engaging and meaningful mathematics learning experiences.

Analysis based on each aspect showed that the learning condition aspect obtained a percentage of 95.38%, the learning difficulties aspect obtained 91.77%, the media needs aspect obtained 92.47%, the educational game and IFP aspect obtained 92.58%, the local culture aspect obtained 92.58%, and the learning support aspect obtained 93.06%. These results indicate that all aspects were in the high category, with the highest percentage found in the learning condition aspect.

The high percentages across all aspects indicate that students need mathematics learning media that are not only visually attractive and interactive but also able to help them understand mathematical concepts more easily. In addition, students also showed a strong need for learning media that integrate game elements, touch-based interaction through IFP technology, local cultural contexts, and learning support in the form of exercises and feedback. Therefore, the development of ethnopedagogy-based educational games has strong relevance to the characteristics and learning needs of elementary school students.

The distribution of students' needs percentages based on each aspect in the development of ethnopedagogy-based educational games using Interactive Flat Panel technology is presented in Figure 2.

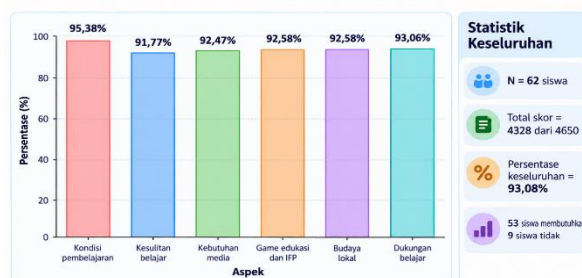


Figure 2. Distribution of Needs Scores Based on Student Responses

Based on Figure 2, the percentage analysis of students' needs shows that all assessed aspects were in the high category. The overall percentage of student needs reached 93.08%, indicating that students strongly need the development of ethnopedagogy-based educational games supported by Interactive Flat Panel technology in mathematics learning. Among the assessed aspects, the learning condition aspect obtained the highest percentage (95.38%), followed by the learning support aspect (93.06%), while the learning difficulties aspect obtained the lowest percentage (91.77%). Although there were slight differences among aspects, all percentages indicate that students showed a high level of need for more interactive, contextual, and engaging mathematics learning media.

These findings suggest that students expect mathematics learning to be presented in a more interesting and understandable way. The high percentage in the media needs and educational game and IFP aspects indicates that students are interested in learning through interactive digital media that involve touch-based activities, visual presentations, and game

elements. In addition, the high percentage in the local culture aspect shows that students also respond positively to learning materials that are connected to their cultural environment. Therefore, the development of ethnopedagogy-based educational games supported by IFP technology can be considered highly relevant to students' learning needs and characteristics.

Discussion

The results of the needs analysis indicate that students show a high level of need for the development of ethnopedagogy-based educational games in elementary school mathematics learning. The overall percentage of student needs reached 93.08%, indicating that students require learning media that provide more interactive, visual, and contextual learning experiences. This finding reflects the characteristics of elementary school students who tend to understand mathematical concepts more effectively through concrete representations, active involvement, and learning activities connected to their daily experiences.

The findings support previous studies on digital game-based learning (DGBL), which demonstrate that educational games can increase student engagement, motivation, and conceptual understanding in mathematics learning. Educational games provide learning experiences through challenges, rules, interaction, feedback, and problem-solving activities, allowing students to construct mathematical understanding through active participation (Dan et al., 2024). Therefore, educational games should not only emphasize attractive visual features but also incorporate appropriate pedagogical elements that support mathematics learning objectives.

In this study, the development of educational games is strengthened through an ethnopedagogical approach. Ethnopedagogy refers to an educational approach that integrates local cultural knowledge, values, practices, and environmental contexts into the learning process. In the context of this research, ethnopedagogical elements are incorporated by presenting mathematical concepts through local cultural contexts that are familiar to students. The cultural context used in the development of the product is the local culture of Musi Banyuasin, particularly cultural objects, local environments, and community activities that can be connected with mathematical concepts.

The integration of local culture into the educational game is designed to support fifth-grade mathematics learning materials, particularly mathematical concepts that require contextual understanding. Local cultural elements can be represented through game scenarios, visual illustrations, learning challenges, and problem situations. For example, mathematical problems can be presented through contexts related to local environments, traditional activities, or cultural objects so that students can identify mathematical concepts within situations that are close to their everyday lives. Through this approach, mathematics is not only learned as an abstract concept but also understood as knowledge that exists within students' social and cultural environments.

The needs analysis findings also provide important implications for the design specifications of the educational game. The high percentage obtained in the educational game and Interactive Flat Panel (IFP) aspect (92.58%) indicates that students require digital learning media equipped with interactive features. Based on this finding, the developed product should include interactive components such as touch-based activities, visual representations, multimedia elements, and navigation features that allow students to actively engage with learning materials.

Furthermore, students' needs for game-based learning indicate that the product should incorporate appropriate game mechanics, including challenges, levels, scores, rewards, and feedback mechanisms. These elements are expected to increase student motivation and encourage students to complete mathematics learning activities through exploration and problem-solving experiences. The integration of challenge and feedback features is

important because students need immediate responses regarding their learning progress during game activities (Russo et al., 2024).

The findings related to the learning media needs aspect (92.47%) and learning support aspect (93.06%) indicate that students require media that can assist them in understanding mathematical concepts and provide opportunities for practice. Therefore, the educational game should contain mathematics content that is aligned with fifth-grade learning objectives, presented through clear explanations, examples, exercises, and interactive activities. The usability aspect of the product should also be considered by ensuring that the game interface is simple, attractive, and appropriate for elementary school students.

In addition, the high percentage obtained in the local culture aspect (92.58%) confirms that students respond positively to the integration of cultural contexts in mathematics learning. The inclusion of ethnopedagogical elements differentiates this product from general digital mathematics games because it combines technological interaction with local cultural values. Previous research has shown that contextualizing learning through cultural environments can help students establish connections between academic concepts and real-life experiences (Wardani & Himmah, 2026).

The teacher interview findings further strengthen the results of the student needs analysis. Teachers explained that students often experience difficulties when mathematical concepts are presented only through verbal explanations and textbook exercises. Teachers indicated that students require learning media containing visual representations, interactive activities, and contextual examples to support their understanding of abstract concepts. These findings confirm that the development of learning media should consider students' cognitive characteristics and provide opportunities for exploration and active participation.

Teachers also emphasized the importance of integrating local cultural contexts into mathematics learning. According to the teachers, mathematical concepts become easier to understand when they are connected with students' surrounding environments and daily experiences. Therefore, the development of ethnopedagogy-based educational games using IFP technology should combine three main components: mathematical content, interactive game features, and local cultural contexts.

Based on the needs analysis findings, the product specifications for the next stage of the ADDIE development model include: (1) interactive learning features supported by Interactive Flat Panel technology; (2) game mechanics involving challenges, levels, scores, and feedback; (3) fifth-grade mathematics content presented through visual and contextual representations; (4) ethnopedagogical integration using local cultural contexts from Musi Banyuasin; and (5) a user-friendly interface appropriate for elementary school students. These specifications provide an empirical foundation for developing an educational game that is engaging, meaningful, and culturally relevant for mathematics learning.

4. Conclusion

Based on the results of the needs analysis, it can be concluded that teachers and students have a high level of need for the development of ethnopedagogy-based educational games supported by Interactive Flat Panel (IFP) technology in fifth-grade elementary school mathematics learning. The analysis results indicate that technology-based and game-based learning media are needed to create mathematics learning environments that are more interactive, engaging, and appropriate to students' characteristics. Therefore, the development of ethnopedagogy-based educational games using Interactive Flat Panel technology can be used as a foundation for the next stage of product development within the ADDIE model.

Thank You Note

The authors would like to express their sincere gratitude to all parties who have contributed to the completion of this research and the preparation of this article.

1. The authors would like to thank Universitas Sriwijaya for providing support and facilities during the research process.
2. The authors express their appreciation to the elementary school teachers and fifth-grade students who participated in this study and provided valuable information during the needs analysis process.
3. The authors would also like to thank colleagues, reviewers, and all individuals who provided constructive suggestions, assistance, and support throughout the research and manuscript preparation process.

The authors hope that this research can contribute to the development of innovative, contextual, and technology-based mathematics learning media for elementary school education.

References

- [1] Branch, R. M. (2009). *Instructional Design: The ADDIE Approach*. New York: Springer. <https://doi.org/10.1007/978-0-387-09506-6>
- [2] Byun, J., & Joung, E. (2018). Digital game-based learning for K-12 mathematics education: A meta-analysis. *School Science and Mathematics*, 118(3–4), 113–126. <https://doi.org/10.1111/ssm.12271>
- [3] Chen, P. Y., Hwang, G. J., Yeh, S. Y., Chen, Y. T., Chen, T. W., & Chien, C. H. (2022). Three decades of game-based learning in science and mathematics education: An integrated bibliometric analysis and systematic review. *Journal of Computers in Education*, 9(3), 455–476. <https://doi.org/10.1007/s40692-021-00210-y>
- [4] Dan, N. N., Trung, L. T. B., Nga, N. T., & Dung, T. M. (2024). Digital game-based learning in mathematics education at primary school level: A systematic literature review. *Eurasia Journal of Mathematics, Science and Technology Education*, 20(4), em2423. <https://doi.org/10.29333/ejmste/14377>
- [5] Hainey, T., Connolly, T. M., Boyle, E. A., Wilson, A., & Razak, A. (2016). A systematic literature review of games-based learning empirical evidence in primary education. *Computers & Education*, 102, 202–223. <https://doi.org/10.1016/j.compedu.2016.09.001>
- [6] Hussein, M. H., Ow, S. H., Elaish, M. M., & Jensen, E. O. (2022). Digital game-based learning in K-12 mathematics education: A systematic literature review. *Education and Information Technologies*, 27(2), 2859–2891. <https://doi.org/10.1007/s10639-021-10721-x>
- [7] Mayer, R. E. (2020). *Multimedia Learning* (3rd ed.). Cambridge: Cambridge University Press.
- [8] Pan, Y., Ke, F., & Xu, X. (2022). A systematic review of the role of learning games in fostering mathematics education in K-12 settings. *Educational Research Review*, 36, 100448. <https://doi.org/10.1016/j.edurev.2022.100448>
- [9] Sugiyono. (2022). *Metode Penelitian Kuantitatif*. Bandung: Alfabeta.
- [10] Vygotsky, L. S. (1978). *Mind in Society: The Development of Higher Psychological Processes*. Cambridge: Harvard University Press.
- [11] Wouters, P., van Nimwegen, C., van Oostendorp, H., & van Der Spek, E. D. (2013). A meta-analysis of the cognitive and motivational effects of serious games. *Journal of Educational Psychology*, 105(2), 249–265. <https://doi.org/10.1037/a0031311>

- [12] Yulianto, A., et al. (2025). Digital game-based learning in mathematics education: A systematic review and meta-analysis. [Lengkapi sesuai artikel asli yang digunakan].
- [13] Zhao, J., Hwang, G. J., Chang, S. C., & Yang, Q. F. (2021). Effects of digital game-based learning on students' mathematics learning performance and motivation. *Educational Technology Research and Development*.