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THE ROLE OF FUN MATH ADVENTURE MEDIA IN DEVELOPING EARLY CHILDHOOD NUMERACY AND PROBLEM-SOLVING SKILLS

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Abstract

This study aims to describe the role of the Fun Math Adventure media in developing early childhood numeracy and problem-solving skills through a phenomenological qualitative approach. Data were collected through participatory observations, in-depth interviews, and documentation, and were analyzed using the interactive model of Miles and Huberman. The credibility of the data was strengthened through technique triangulation and member checking with teachers to ensure the consistency and accuracy of the findings. The results indicate that Fun Math Adventure enhances children's focus, persistence, and engagement in numeracy activities, while also encouraging the emergence of independent problem-solving strategies. The digital environment further enriches social interactions by facilitating collaborative discussions and shared exploration among children. In addition, the use of this media provides teachers with opportunities to design more adaptive, varied, and child-centered learning experiences. The study contributes new insights into the effective integration of play-based learning and digital media in early childhood education, and offers practical implications for teachers implementing the Merdeka Curriculum.

Keyword: *Digital Media; Early Numeracy; Fun Math Adventure; Early Childhood Education*

INTRODUCTION

The development of digital technology has increasingly become part of children's lives in the modern era. In various early childhood education institutions, the use of digital devices such as laptops, tablets, and interactive flat panels has gradually been integrated into the learning process. Children grow up in environments rich in visual stimuli, sounds, and interactive animations that easily capture their attention. In this context, the use of digital media becomes highly relevant for early childhood education. Recent studies confirm that digital technology can expand children's learning experiences when used appropriately, aligned with their developmental stages, and grounded in child-centered pedagogical principles (Lismayani & Pratama, 2025). Technology not only functions as a supporting tool but also serves as a new space for children to explore, observe, and construct meaning through active interaction.

In Indonesia, the Merdeka Curriculum emphasizes the importance of learning that provides opportunities for exploration, creativity, and independence. One of the fundamental skills that needs to be developed from an early age is numeracy. Numeracy encompasses not only

counting skills but also the understanding of patterns, number relationships, estimation, and the application of numbers in everyday contexts. Previous studies indicate that early mastery of numeracy serves as a foundation for long-term mathematical thinking (Sugiatno et al., 2023). However, classroom practices show that many young children experience difficulties in understanding numeracy concepts because learning tends to be abstract. A preliminary study conducted in one partner kindergarten revealed that 62% of children had difficulty maintaining focus during conventional numeracy activities, while teachers reported that the methods used were not aligned with children's play-based learning styles (Preliminary observation, 2024).

According to cognitive development theory, children aged 4–6 years are in the preoperational stage, in which they understand the world through visual representations and concrete activities. Therefore, children require learning media that allow them to see, touch, and manipulate objects in order to understand abstract concepts. Recent research in multimedia learning shows that the combination of visuals, sound, and interactivity can enhance conceptual understanding while reducing cognitive load (Tenenbaum et al., 2024). Other studies have found that interactive digital media help children process information more efficiently through structured visual presentation (Al-Hassan et al., 2025). Thus, digital media such as adventure-based mathematics games have strong potential to provide learning experiences that align with early childhood learning characteristics, namely learning through play, exploration, and multisensory interaction.

Fun Math Adventure is a digital learning medium based on an adventure-style numeracy game designed for early childhood through a combination of visual activities, physical games, and digital interaction. This medium integrates a snakes and ladders board game with interactive numeracy activities displayed on an interactive flat panel. As a result, children not only observe numbers but also move, count, match quantities of objects, and solve simple challenges directly. The activities include number sequencing, matching number symbols with quantities, and solving numeracy challenges through drag-and-drop mechanisms and visual exploration. The use of bright colors, animated characters, and immediate feedback makes the learning experience more engaging and aligned with the concrete and play-based characteristics of early childhood learning.

Figure 1 shows the snakes and ladders board used in the Fun Math Adventure media.

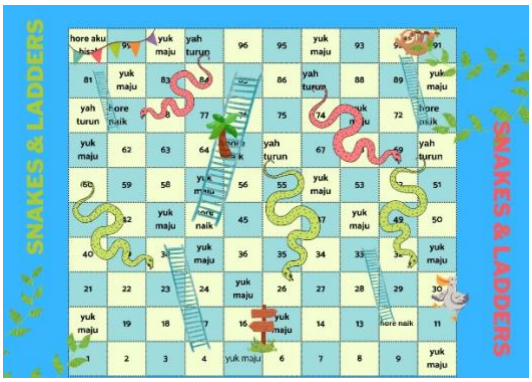
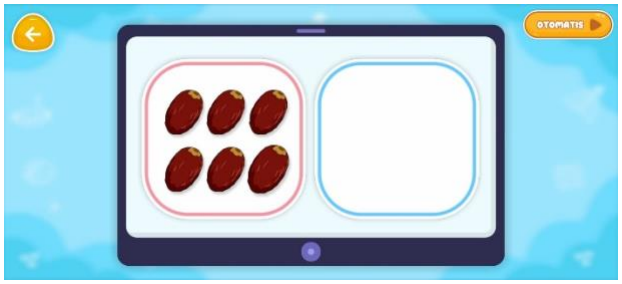


Figure 2 illustrates an example of a number sequencing activity in the Fun Math Adventure media.

Figure 3 illustrates an activity involving counting and matching quantities of objects with number symbols.



Through the integration of physical games and interactive digital activities, Fun Math Adventure provides a multisensory learning experience that allows children to engage visually, motorically, and cognitively at the same time. This experience helps children understand numeracy concepts in a more concrete and meaningful way. The use of bright visuals, animated characters, and immediate feedback increases children's motivation and focus. Recent studies indicate that digital game-based learning enhances motivation, attention, and numeracy understanding in early childhood (Papadakis et al., 2021; Kim et al., 2021). Neumann (2020) also found that digital applications can improve literacy and numeracy through manipulative and multisensory interaction. In addition, the use of visual representations that can be directly manipulated has been shown to provide more meaningful numeracy experiences for children (Aladil & Alsaeed, 2024).

However, the use of digital media is not without concerns, particularly regarding the risk of children becoming passive or overly focused on screens. Nevertheless, recent studies confirm that these risks can be minimized when technology is used with teacher guidance and through structured pedagogical approaches. Tenenbaum et al. (2024) state that teacher involvement in digital play can enhance children's social interaction, communication, and collaborative skills. Edwards (2022) also found that digital play can foster discussion, cooperation, and communication among children when teachers provide minimal yet effective guided participation. Thus, technology does not replace real play but rather expands children's play space through meaningful and collaborative new experiences. In practice, early childhood teachers report that numeracy learning is one of the most challenging aspects, as children often lose focus during abstract activities. Conventional methods such as worksheets are not well aligned with the play-based learning characteristics of young children. Digital media such as Fun Math Adventure offer a relevant solution by providing interactive, enjoyable, and dynamic learning experiences. In addition to improving counting skills, this medium also helps children develop problem-solving strategies, fine motor skills, and social interaction through spontaneous discussions that occur during play (Al-Hassan et al., 2025).

Although research on digital media and numeracy is quite extensive, most previous studies focus on learning outcomes or final achievement. In early childhood education, however, the learning process is more important for understanding how children construct meaning through cognitive, social, and emotional experiences. Studies conducted between 2023 and 2024 indicate that children's learning experiences should include how they explore, respond to challenges, develop strategies, and express social behaviors during activities (Tenenbaum et al., 2024; Sugiatno et al., 2023). In addition, phenomenological research on early childhood learning experiences using Fun Math Adventure in Indonesia remains very limited. Therefore, it is important to explore how numeracy learning processes occur from the perspective of children's lived experiences.

Based on this research gap, this study aims to describe in depth the numeracy learning experiences of early childhood children when using the Fun Math Adventure digital media through a phenomenological approach. This study also offers novelty by revealing children's numeracy learning experiences in a holistic and contextual manner, rather than merely evaluating learning outcomes. It is expected that this study will provide both theoretical and practical contributions for early childhood teachers in designing more meaningful digital media-based numeracy learning that aligns with children's ways of learning.

METHODOLOGY

This study employed a qualitative approach with a phenomenological design to gain an in-depth understanding of early childhood learning experiences when using the Fun Math Adventure digital media. A phenomenological design was chosen because it allows researchers to explore the meaning of lived experiences as directly experienced by children in a natural context. Max van Manen (2016) states that phenomenology seeks to uncover the essence of human experience through observation, reflection, and in-depth interpretation of actions and expressions. This approach is highly relevant in early childhood education research, as children aged 5–6 years often express meaning through movement, facial expressions, and spontaneous interaction rather than through extended verbal explanations. John W. Creswell and Cheryl N. Poth (2018) also emphasize that phenomenology is appropriate when the purpose of the study is to explore the essence of experiences that cannot be reduced to numerical data or standardized instruments.

The researcher acted as the primary instrument in this study. The researcher's presence in the classroom was conducted in a non-intrusive manner so that children continued to behave naturally. The researcher carried out observations, engaged in limited communication with the teacher, recorded children's responses, and documented interactions that occurred during the learning activities. All procedures were conducted with careful attention to research ethics, children's comfort, and privacy protection principles.

This study was conducted at UPT TK Negeri Pembina Bugul Kidul. This location was selected because the institution has implemented digital devices in learning, including the use of interactive flat panels, thus providing an ideal context for observing digital learning experiences. The participants consisted of 15 children from Group B aged 5–6 years as the main participants and one classroom teacher as a supporting informant. Participants were selected using purposive sampling, which involves selecting individuals who are considered to have relevant experience related to the phenomenon under study. Children in Group B were chosen because, at this age, they are able to follow simple visual instructions, demonstrate spontaneous responses, and begin to develop basic problem-solving strategies. Meanwhile, the

teacher was selected as an informant due to their in-depth knowledge of children's behavior and development in daily learning settings.

Data were collected through participatory observation, semi-structured interviews, and photo documentation. Participatory observation was conducted to directly capture how children interacted with Fun Math Adventure, including how they maintained focus, responded to challenges, collaborated with peers, and expressed emotions during play. Rosie Flewitt (2014) emphasizes that participatory observation is essential in early childhood research because many children's expressions appear in nonverbal forms. Therefore, observation records included not only children's behaviors but also classroom atmosphere, digital device conditions, lighting intensity, and interactions among teachers, children, and the media.

Semi-structured interviews were conducted with one Group B teacher to gain deeper insight into the observational findings. The teacher was given the opportunity to share experiences and observations narratively while still guided by a set of prepared questions.

Table 1. Teacher Interview Indicators

Interview Aspect	Indicators Explored
Children's Focus and Engagement	Children's attention during learning, ability to maintain concentration, and enthusiasm in participating in numeracy games
Problem-Solving Strategies	How children solve numeracy challenges, use counting strategies, and attempt to retry when answers are incorrect
Social Interaction	Forms of discussion among children, collaboration during play, and children's responses to peers' assistance or comments
Emotional Responses	Expressions of enjoyment, self-confidence, persistence, and children's responses when succeeding or making mistakes
Learning Experience	Teacher's perceptions of the use of digital media in supporting early childhood numeracy learning

The interviews explored the teacher's perceptions of children's focus, the development of motivation, emerging social interactions, and changes in problem-solving strategies following the use of digital media. The semi-structured interview approach, as explained by John W. Creswell and Cheryl N. Poth (2018), enables the researcher to capture information that may not emerge through direct observation.

Visual documentation in the form of activity photographs, game screenshots, and teacher notes was used to strengthen the data obtained from observations and interviews. Lexy J. Moleong (2006) explains that documentation can capture details of reality that are not always recorded through observation or interview notes, particularly those related to nonverbal expressions and group dynamics. The photographs in this study were taken from safe angles without revealing the children's identities.

Data analysis followed the interactive analysis procedure of Matthew B. Miles, A. Michael Huberman, and Johnny Saldaña (2014), which consists of data reduction, data display, and conclusion drawing. During the data reduction stage, the researcher repeatedly reviewed all observation notes, interview transcripts, and visual documentation to identify meaningful units. This process was carried out through open coding, by marking relevant words, phrases, or actions such as "increased focus," "helping peers," "using fingers as a strategy," or "positive emotional responses." These codes were then grouped through axial coding into broader

categories, such as children's engagement, problem-solving strategies, social interaction, and emotional responses. Furthermore, through selective coding, the researcher identified key themes that reflect the essence of children's experiences while interacting with the Fun Math Adventure media. To facilitate understanding of the data analysis stages used in this study, the researcher presents a visual representation of the data analysis procedure as follows.

Figure 4. Research Data Analysis Procedure

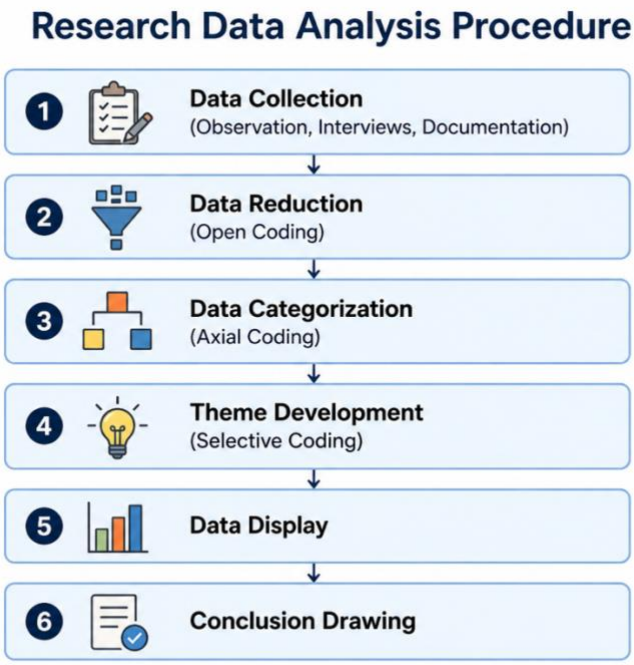


Figure 4 illustrates the data analysis procedure used in this study. The analysis was conducted in stages, beginning with data collection, followed by data reduction through the process of open coding, category grouping through axial coding, and the identification of main themes through selective coding. The entire process was carried out in an interactive and iterative manner until a deep understanding of children's learning experiences while using the Fun Math Adventure media was achieved.

To ensure data validity, this study applied technique triangulation, source triangulation, and member checking. Technique triangulation was conducted by comparing data obtained from observations, interviews, and documentation to ensure that findings appeared consistently across different types of data, as explained by Norman K. Denzin (2012). Source triangulation was carried out by cross-checking information from children, teachers, and visual documents to obtain a comprehensive understanding of the phenomenon under study. Member checking was conducted at the final stage by confirming preliminary findings with the teacher to ensure that the researcher's interpretations were consistent with actual classroom conditions. John W. Creswell and Cheryl N. Poth (2018) identify member checking as one of the most powerful validation techniques for ensuring credibility in qualitative research.

Through the combination of a phenomenological approach, the researcher's direct presence, rich data collection techniques, and systematic data analysis, this research method was designed to produce an in-depth, authentic, and comprehensive understanding of early childhood numeracy learning experiences in the context of using the Fun Math Adventure digital media.

RESULTS AND DISCUSSION

This study aims to gain an in-depth understanding of how early childhood children experience numeracy learning through the Fun Math Adventure digital media. Using a phenomenological approach, this study reveals children's learning experiences not only from a cognitive perspective but also from social, emotional, and strategic aspects that they employ in solving mathematical challenges. The findings integrate data from participatory observations, teacher interviews, and photo documentation to provide a holistic view of children's learning processes. The results indicate that digital media function not merely as instructional tools but also as spaces for exploration that enable children to construct their understanding of numeracy in an independent, natural, and enjoyable manner.

Digital Children's Focus and Engagement in Digital Activities

At the initial stage of the activity, children showed strong responses when Fun Math Adventure was first displayed on the interactive flat panel. Spontaneously, they approached the screen, focused their attention on the visuals, and began mentioning the numbers or objects presented. This pattern consistently appeared in each session, indicating that the digital game provided strong stimuli for capturing children's attention.

Photo documentation shows children crouching or standing close to the screen, demonstrating that their visual focus was fully directed toward the activity. No children showed signs of boredom during the initial phase of learning. Instead, they remained attentive to the numeracy displays on the interactive flat panel throughout the Fun Math Adventure activities.

Figure 5. Children focusing on numeracy displays on the interactive flat panel during Fun Math Adventure activities.

Activity documentation shows that children concentrated their attention on the visual display of the game and demonstrated enthusiasm when numeracy challenges appeared on the screen. They were actively engaged in observing visual instructions and waiting for their turn to participate in solving the tasks. Even children who were usually less enthusiastic about numeracy activities showed clear interest during the activity.

Teacher interviews provided additional insight, indicating that children's focus was not limited to the initial minutes but was sustained throughout the activity. The teacher reported that children appeared "more focused and less likely to look away," in contrast to paper-based numeracy learning, which often led to rapid disengagement. These findings are consistent with Richard E. Mayer (2009), who argues that interactive media incorporating visual and auditory elements can enhance children's attention capacity by creating multisensory learning

experiences. In the context of numeracy, the visualization of numbers, counting objects, and supporting animations provides more concrete stimuli compared to numbers presented on paper.

This pattern of engagement also indicates that Fun Math Adventure offers a highly engaging learning experience. Children were willing to continue the activity voluntarily without feeling pressured by the teacher. Based on observation notes, several children spontaneously said, "Let's continue, Teacher!" after completing one level of the game. Another child remarked, "Try again if it's wrong," when a peer did not answer correctly. In addition, when the researcher asked, "Do you still want to play again?" one child responded, "Yes, it's fun." These spontaneous expressions reflect intrinsic motivation that encourages children to continue exploring the game and independently attempt to solve numeracy challenges. This finding aligns with Stavros Papadakis et al. (2018), who found that digital games based on mathematical challenges increase children's engagement by providing immediate and predictable feedback, thereby encouraging repeated attempts.

Figure 6. Children demonstrating enthusiasm while attempting to solve numeracy challenges using the Fun Math Adventure media.

Photographs Activity show that children voluntarily expressed a desire to continue the game without direct prompting from the teacher. Spontaneous responses, such as asking to try again and displaying joyful expressions, indicate children's emotional engagement throughout the learning process. This finding is consistent with Stavros Papadakis et al. (2018), who found that digital games based on mathematical challenges enhance children's engagement by providing immediate and predictable feedback, thereby encouraging them to try again.

Overall, children's focus and engagement can be summarized through the following indicators:

Table 2. Indicators of Children's Focus and Engagement

Indicator	Description of Observed Children's Behavior
Initial Attention	Children approach the interactive flat panel and pay attention to the game display when the activity begins
Concentration	Children follow visual instructions and remain focused on the game without being easily distracted

Persistence	Children attempt to retry the game when answers are incorrect and continue until the challenges are completed
Motivation	Children demonstrate a willingness to continue the game and voluntarily try the next level
Enthusiasm	Children display positive expressions such as smiling, laughing softly, clapping, and making spontaneous comments during the activity

The table shows that all indicators of children's focus and engagement consistently appeared throughout the activities. Even when the teacher paused the session to provide additional instructions, children appeared eager to return to the game. They independently developed an active learning rhythm, in which they seemed "drawn" to the flow of the game. This finding aligns with Susan Edwards (2022), who suggests that digital media can create an engaged learning environment that integrates curiosity, challenge, and enjoyment.

Problem-Solving Strategies of Early Childhood Children

Problem-solving strategies emerged as one of the key findings of this study. Children did not merely follow the game instructions in a linear manner; rather, they demonstrated a variety of spontaneous approaches in solving numeracy challenges presented through the Fun Math Adventure media. Based on observational data, several children were seen counting objects one by one while pointing at images on the screen. They used hand movements to ensure that the number of objects matched the numbers displayed in the game. One child was observed quietly saying, "One, two, three…" while pointing to the objects before selecting an answer.

In addition, some children used their fingers to support the counting process and to match quantities with number symbols. The teacher reported that children tend to "understand quantities more easily when they can see and directly point to the screen." This finding indicates that children rely on concrete approaches in understanding numerical concepts. Such strategies are consistent with the preoperational stage proposed by Jean Piaget (1964), in which children understand concepts through visual activities and physical actions that support cognitive processes. Overall, the observations indicate that children employed various concrete strategies when solving numeracy challenges in the Fun Math Adventure media. They were seen pointing to objects one by one, counting using their fingers, and carefully observing visual displays before determining their answers.

Figure 7. Children using their fingers and pointing at objects on the screen while completing counting activities.

Activity documentation shows that numeracy learning experiences occurred through visual activities and concrete actions that helped children understand the relationship between the quantity of objects and number symbols. On the other hand, some children used their fingers to match quantities with the numbers displayed on the screen. When encountering small quantities, children were able to immediately identify the number without counting, indicating the emergence of subitizing ability, which is an important component of early numeracy development. This phenomenon suggests that digital media provide a rich visual context that supports the development of natural strategies for understanding numbers. Douglas H. Clements and Julie Sarama (2016) emphasize that repeated visual representations can strengthen children's understanding of quantity and number relationships.

Trial-and-error behavior also emerged prominently. When children selected incorrect answers, they immediately pressed the retry button and attempted the task again without hesitation. This indicates that the digital media created a safe learning environment in which children could make mistakes without feeling pressured. The teacher noted that "children become even more enthusiastic when they make mistakes because they find the challenge engaging." This finding suggests that Fun Math Adventure fosters an error-friendly learning experience that supports mastery motivation (Morgan et al., 1990). In addition to using concrete counting strategies, children consistently demonstrated a willingness to retry when their answers were incorrect. They did not appear afraid of making mistakes; instead, they were encouraged to repeat the activity until they found the correct answer. This situation indicates that the Fun Math Adventure media provide a safe and enjoyable learning environment that supports children's exploration.

Figure 8. Children attempting the numeracy game again after selecting an incorrect answer.

Activity documentation shows that children demonstrated persistence in completing numeracy challenges through processes of trying, observing, and independently correcting their answers.

The various strategies observed can be summarized in the following table:

Table 3. Children's Problem-Solving Strategies

Strategy	Field Findings
Pointing to Objects	Counting while pointing to objects one by one
Using Fingers	Raising fingers to match the quantity
Subitizing	Providing immediate responses for small quantities without counting
Trial and Error	Repeating the task after incorrect answers without waiting for instructions

Social Observation	Observing and imitating peers' strategies before attempting independently

Interestingly, some strategies developed through social interaction. Children who initially appeared confused tended to observe their peers before attempting the task independently, indicating a process of social referencing. This phenomenon reinforces the perspective of Lev Vygotsky (1978), which emphasizes that children learn through interaction with their social environment. The combination of individual and social strategies contributes to a rich and multidimensional numeracy learning process.

Social Interaction in Digital Learning

Although digital games are often considered individual activities, this study shows that social interaction developed strongly during the learning process. Children engaged in discussions, asked questions, commented on their peers' strategies, and provided spontaneous assistance. Photo documentation shows two to three children standing side by side in front of the screen, pointing at objects and talking to one another. Such interactions reflect the phenomenon of shared attention, where two or more children focus on the same object simultaneously. The teacher reported that digital activities made children more communicative. Children who were usually passive during classroom discussions became more willing to express their opinions during the activity. One child stated, "That's wrong, try counting again," demonstrating the ability to provide constructive feedback to peers. Children were also observed celebrating their peers' success through clapping or short expressions such as "Good job!" or "Yay, you did it!" This pattern indicates that digital activities support children's social development in a natural and enjoyable way.

These findings are consistent with Susan Edwards (2022), who argues that digital play in group contexts can stimulate discussion, negotiation, and collaboration among children. Technology is not a barrier to interaction; rather, it serves as a tool that expands communication when used in appropriate learning environments. In this study, the teacher's role in facilitating interaction was relatively minimal. The teacher mainly observed and provided light guidance, while interactions among children occurred spontaneously and independently. The observed social interactions also support the theory of Lev Vygotsky, which emphasizes that learning occurs through the internalization of social experiences. Children learned not only from the media but also from their peers. This type of collaborative learning enriched children's understanding of numeracy concepts and problem-solving strategies. In other words, digital media created a space for children to construct socially interactive learning experiences, rather than purely individual ones.

Children's Emotional Responses in Digital Learning

Children's emotional responses emerged as one of the key findings of this study. They demonstrated expressions of enthusiasm, enjoyment, curiosity, and confidence while using the Fun Math Adventure media. These emotional responses were evident through facial expressions, spontaneous clapping, willingness to retry tasks, and direct conversations with the researcher during the activity. When the researcher asked, "Do you enjoy this game?" one child responded, "Yes, it's fun, I want to play again." Another child said, "I'm happy when I get the right answer." These spontaneous expressions indicate that children experienced positive emotional engagement during digital game-based numeracy learning.

Children appeared to enjoy the learning process and consistently displayed positive emotions throughout the activity. They smiled when successfully completing challenges, laughed softly when animations appeared, and even called the teacher or peers to show their achievements.

When making mistakes, children did not show disappointment; instead, they were eager to try again. This pattern was observed in almost all children, indicating that Fun Math Adventure provides a positive and supportive emotional learning experience. The teacher reported that children appeared "more confident" and "not afraid of making mistakes." This is particularly important in numeracy learning, as fear of making mistakes often hinders children's thinking processes. With digital media, mistakes were perceived as part of the game rather than as failure. This supports the concept of error-friendly learning in early childhood education, where mistakes become part of exploration without negative emotional burden. These findings are consistent with John W. Santrock (2011), who states that positive emotions enhance children's motivation and engagement in learning. Kathy Hirsh-Pasek et al. (2015) also highlight that digital play provides a guided play context that supports children's social-emotional development. In this study, strong emotional responses indicate that children not only understood numeracy concepts cognitively but also developed emotional connections with the learning process.

Visualization of Children's Learning Process

To provide a holistic overview of children's learning experiences, the following flow was developed based on the results of observations and interviews.

Figure 9. Children's Interaction Flow in Fun Math Adventure Learning

The flow illustrates that the learning process begins with initial attention, followed by children attempting to understand visual instructions, developing strategies, receiving feedback from the media, refining their strategies, and ultimately forming social interactions. The diagram indicates that children's learning processes are dynamic and occur simultaneously across cognitive, emotional, and social dimensions.

Implications for Learning

The findings of this study provide important implications for numeracy learning in early childhood education. First, digital media such as Fun Math Adventure can serve as an effective and engaging learning tool. Children demonstrated longer attention spans, higher levels of active engagement, and greater willingness to try new strategies. Second, the emergence of social interaction indicates that digital media can enrich, rather than diminish, the social dimension of learning. Third, the positive emotional responses observed suggest that digital media create a safe and child-friendly learning environment, aligning with the principles of guided play in early childhood education. In the context of the Merdeka Curriculum, exploration-based learning of this kind is highly relevant. Teachers can utilize digital media as a complement to concrete play activities, rather than as a replacement. The use of technology should continue to consider pedagogical values, child development, and supportive social interactions. These findings are also in line with recommendations from UNESCO (2019),

which emphasize the importance of integrating technology in early childhood education in a thoughtful and purposeful manner.

The findings reveal that numeracy learning through Fun Math Adventure is not merely a process of understanding numbers, but a holistic learning experience that engages multiple aspects of children's development. Children not only learn to count, but also develop confidence, collaboration skills, persistence in the face of challenges, and the ability to celebrate small successes with joy. This digital media provides a safe space for children to explore without fear of judgment, strengthens their relationships with peers and teachers, and helps them discover learning approaches that suit them best. These experiences suggest that when technology is used with appropriate guidance and sensitivity, it can serve as a bridge for children to engage with numeracy in ways that are enjoyable, meaningful, and aligned with their natural inclination to learn through play. Thus, Fun Math Adventure not only introduces instructional innovation but also supports children in becoming active, confident, and curious learners.

Overall, the findings indicate that the use of Fun Math Adventure helps children build more vivid and meaningful numeracy learning experiences. Children appeared more focused, more willing to take risks, and more open to collaboration during digital learning activities. These experiences also demonstrate that technology should not be viewed as something that distances children from social interaction, but rather as a bridge that connects them through play and exploration. However, this study has several limitations that should be acknowledged. The relatively small number of participants from a single institution limits the generalizability of the findings. The short duration of the study also restricts the ability to observe the long-term development of children's strategies and behaviors. In addition, the study focused on a single type of digital media, which does not allow for comparison with other platforms. Although the findings were validated through triangulation and member checking, the researcher acknowledges that some interpretations remain influenced by the researcher's perspective.

This study contributes not only to the local context but also to the global discourse on the use of digital media in early childhood education. While digital game-based learning has been widely studied at the primary school level, phenomenological research focusing on young children's learning experiences remains limited. Recent studies, such as those conducted by Alsaeed and Aladil (2024), Kim et al. (2021), and Tenenbaum et al. (2024), have shown that digital applications can enhance children's focus, problem-solving strategies, and social interaction. However, most of these studies employ quantitative or experimental approaches. Therefore, this study offers a significant contribution by providing a qualitative perspective that captures children's learning experiences in a direct, natural, and in-depth manner. The phenomenological approach further enriches global understanding of how young children construct meaning in numeracy learning—not only in terms of outcomes but also through emotional, social, and cognitive experiences.

Furthermore, the findings align with international research emphasizing the importance of interactive, visual, and responsive digital game design. Studies by Papadakis et al. (2021) and Neumann (2020) highlight that features such as immediate feedback, progressive challenges, and visual manipulation can foster intrinsic motivation and concentration. The present study supports these findings while demonstrating that such design principles are also effective within the Indonesian early childhood education context. This suggests that young children share universal learning characteristics that can be supported through developmentally appropriate digital media. Thus, this study not only confirms global findings but also provides

empirical evidence that digital learning tools can be effectively adapted across diverse socio-cultural contexts. From a policy and educational practice perspective, these findings offer important implications for the development of numeracy learning in early childhood education. The observation that children become more focused, confident, and willing to explore new strategies suggests that digital media can function as a valuable complement to concrete play-based learning within the Merdeka Curriculum. This aligns with global recommendations emphasizing that technology integration in early childhood education should be implemented thoughtfully and in alignment with active pedagogical principles. Teachers can leverage digital media to create more dynamic, interactive, and child-friendly numeracy learning experiences without compromising the essential values of play and social interaction. Early childhood institutions may also use these findings as a basis for designing teacher training programs focused on pedagogically sound digital integration.

This study also provides several recommendations for practitioners and researchers. For early childhood teachers, digital media such as Fun Math Adventure can be integrated with discussions, role-playing, and hands-on activities to create more balanced numeracy learning experiences. Teachers should also provide opportunities for exploration, allowing children to develop strategies and build confidence in solving numeracy challenges. For researchers, future studies may compare different digital applications, extend the duration of research, or examine the long-term development of children's strategies. Longitudinal approaches, in particular, may offer deeper insights into how early digital learning experiences shape numeracy competencies over time.

In conclusion, the integration of global perspectives, policy implications, and practical recommendations strengthens the novelty and contribution of this study to the development of digital pedagogy in early childhood education at both national and international levels. Despite its limitations, this study provides meaningful insights into how digital media can be positioned within numeracy learning and opens opportunities for further research that is broader, deeper, and more contextually grounded.

CONCLUSION

This study concludes that Fun Math Adventure plays a significant role in shaping more focused, interactive, and meaningful numeracy learning experiences for young children. The media facilitates the emergence of diverse problem-solving strategies, encourages children to retry after making mistakes, and strengthens social interaction during play activities. These findings indicate that digital learning can provide experiences aligned with the study's objective, namely to understand how children construct meaning in numeracy through play-based activities. The essence of this study highlights that technology can enrich children's knowledge construction processes in a natural and developmentally appropriate manner.

REFERENCES

Alderson, P., & Morrow, V. (2011). *The ethics of research with children and young people: A practical handbook.* SAGE Publications.

Aladil, N., & Alsaeed, D. (2024). The effect of digital math games on early numeracy development: A systematic review. *Early Childhood Education Journal, 52*(1), 145–160. https://doi.org/10.1007/s10643-023-01553-7

Al-Hassan, O., Al-Jubaili, M., & Hussein, K. (2025). Interactive digital learning environments and cognitive engagement in early childhood mathematics. *Journal of Educational Technology & Society, 28*(2), 34–49.

Clements, D. H., & Sarama, J. (2016). *Learning and teaching early math: The learning*

trajectories approach. Routledge.
Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry and research design: Choosing among five approaches* (4th ed.). SAGE Publications.
Denzin, N. K. (2012). Triangulation 2.0. *Journal of Mixed Methods Research, 6*(2), 80–88.
Edwards, S. (2022). Digital play in early childhood: What it is, why it matters, and what it looks like in practice. *Early Childhood Education Journal, 50*, 1101–1114. https://doi.org/10.1007/s10643-021-01233-7
Fleer, M. (2020). *Digital children: A sociocultural approach to understanding child development in the digital age.* Cambridge University Press.
Flewitt, R. (2014). Interviews, observations, and ethnography: Multiple methods in literacy research. In P. Albers et al. (Eds.), *Handbook of research on teaching literacy through the communicative and visual arts* (Vol. 2). Routledge.
Ginsburg, H. P., Lee, J. S., & Boyd, J. S. (2021). Mathematics learning in early childhood. In S. Sheridan & J. E. Fleer (Eds.), *Early childhood education and development* (pp. 109–130). Routledge.
Hirsh-Pasek, K., Zosh, J. M., Golinkoff, R., Gray, J., Robb, M., & Kaufman, J. (2015). Putting education in "educational" apps: Lessons from the science of learning. *Psychological Science in the Public Interest, 16*(1), 3–34. https://doi.org/10.1177/1529100615569721
Kim, J., Park, S., & Oh, H. (2021). Effects of interactive mathematics apps on young children's numeracy and engagement. *British Journal of Educational Technology, 52*(4), 1708–1724. https://doi.org/10.1111/bjet.13135
Lismayani, R., & Pratama, G. A. (2025). The effectiveness of Mathematics 2.0 learning through digital educational games in stimulating early childhood mathematical abilities. *Eduline: Journal of Education and Learning, 7*(1), 113–128.
Mayer, R. E. (2009). *Multimedia learning* (2nd ed.). Cambridge University Press.
Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Qualitative data analysis: A methods sourcebook* (3rd ed.). SAGE Publications.
Moleong, L. J. (2006). *Metodologi penelitian kualitatif.* PT Remaja Rosdakarya.
Morgan, G. A., Harmon, R. J., & Maslin-Cole, C. (1990). Mastery motivation: Definition and measurement. *Early Education and Development, 1*(5), 318–339.
Neumann, M. M. (2020). Young children and digital technology: Interactive digital math play and emergent numeracy. *British Journal of Educational Technology, 51*(5), 1548–1564. https://doi.org/10.1111/bjet.12974
Papadakis, S., Kalogiannakis, M., & Zaranis, N. (2021). Improving mathematics learning in kindergarten with educational apps: A quasi-experimental study. *Computers & Education, 176*, 104956. https://doi.org/10.1016/j.compedu.2021.104956
Piaget, J. (1964). Development and learning. In R. Ripple & V. Rockcastle (Eds.), *Piaget rediscovered*. Cornell University.
Santrock, J. W. (2011). *Educational psychology* (5th ed.). McGraw-Hill.
Sugiatno, S., Mursalin, M., & Putra, H. (2023). Early childhood mathematics learning profile: Understanding numeracy readiness. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini, 7*(4), 3850–3862. https://doi.org/10.31004/obsesi.v7i4.4023
Tenenbaum, H. R., Alfieri, L., & Fong, C. (2024). How digital tools support children's cognitive engagement: A review of recent evidence. *Learning, Culture and Social Interaction, 41*, 100741. https://doi.org/10.1016/j.lcsi.2023.100741
UNESCO. (2019). *Guidance on digital learning for early childhood education*. UNESCO Publishing.
Van Manen, M. (2016). *Phenomenology of practice: Meaning-giving methods in phenomenological research and writing.* Routledge.
Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes.* Harvard University Press.