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Teachers' perspectives on implementing microlearning in numeracy literacy in elementary schools

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Abstract: This study aims to describe the current conditions of numeracy literacy learning in elementary schools and analyze the needs for developing microlearning-based e-modules as an innovative solution to support the implementation of the Merdeka Curriculum. The study was motivated by the fact that numeracy instruction in schools remains dominated by traditional approaches, with limited integration of contextual digital media and minimal innovation in teaching practices. A descriptive qualitative approach was applied, involving five elementary schools in the Moyudan District, Sleman Regency, Yogyakarta Special Region. Participants consisted of five fifth-grade teachers and 83 students selected through purposive sampling. Data were collected through classroom observations, semi-structured interviews, and documentation, and analyzed using the Miles and Huberman interactive model. The findings revealed that while teachers recognize the importance of strengthening numeracy literacy as a 21st-century competence, they face various challenges, including limited time, insufficient digital pedagogical training, and the unavailability of relevant learning materials. The results highlight that the microlearning approach is pedagogically relevant because it provides concise, contextual, and interactive learning experiences that enhance students' conceptual understanding and engagement. The study concludes that developing microlearning-based e-modules has significant potential to improve the quality of numeracy literacy learning in elementary schools, supporting a more adaptive, participatory, and technology-integrated learning environment.

Keywords: numeracy literacy, microlearning, Merdeka curriculum

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Introduction

Numeracy is a fundamental competency in education and plays a crucial role in modern life. It is not merely limited to arithmetic skills but also encompasses the understanding of mathematical concepts, data interpretation, numerical information analysis, and the application of these skills in solving everyday problems (Rakhmawati & Mustadi, 2022; Vitantri & Syafrudin, 2022). These competencies serve as the foundation for students to develop logical, critical, creative, and reflective thinking from an early age.

As one of the key competencies of the 21st century, numeracy literacy determines individuals' readiness to face technological advancements and the dynamics of modern life (Afifah et al., 2023; Kurniawan et al., 2024; Suharja et al., 2024). Sa'diyah et al. (2024) emphasize that mathematical literacy not only enhances technical skills but also strengthens the ability to apply mathematics in real-world contexts. Similarly, Susanta et al., (2023) found that integrating real-life scenarios into numeracy learning improves students' understanding and engagement. Hurst (2007) further argues that relevant contextual situations can foster students' intrinsic motivation to explore mathematics more deeply.

Furthermore, strengthening learning motivation and problem-solving skills are essential factors in developing a positive mathematical disposition. Research findings reveal that when both factors are considered simultaneously, problem-solving ability becomes a stronger predictor of mathematical

disposition than learning motivation alone. While motivation encourages active participation, problem-solving skills are directly linked to students' constructive attitudes toward learning mathematics (Anggraeni et al., 2025).

The Indonesian government, through the *Merdeka Belajar* (Freedom to Learn) policy, positions numeracy as one of the main indicators for improving national education quality. The implementation of the National Assessment *(Asesmen Nasional)* and Indonesia's participation in international studies such as the Programme for International Student Assessment (PISA) reaffirm the significance of numeracy literacy as a benchmark for educational quality. However, the OECD (2022) report shows that Indonesia ranked 69th out of 81 participating countries, with a score of 366, 106 points below the global average. This indicates that most Indonesian students still struggle to achieve the minimum proficiency level, particularly in understanding basic mathematical concepts, interpreting data, and applying contextual problem-solving strategies (Ayuningtyas et al., 2024).

A preliminary study conducted in five elementary schools in the Moyudan District revealed that while teaching practices have referred to the Merdeka Curriculum, the teaching materials used remain limited to the textbooks provided by the Ministry of Education and regional student worksheets (LKS). Some teachers have begun to innovate by utilizing media such as PowerPoint, concrete learning aids, and contextual approaches. However, most students still struggle to grasp abstract mathematical concepts and tend to be passive during classroom discussions. Interviews with teachers also revealed that students were more enthusiastic when lessons were presented using engaging media such as images, videos, or interactive tools, whereas conventional methods quickly led to loss of focus.

Several studies support these findings. Although numeracy-based learning has begun to be implemented (Suwandayani et al., 2020), several challenges persist. Murtafiah et al. (2021) reported that elementary students' numeracy skills remain relatively low. Abidin et al. (2022) further explained that the main causes include difficulties in understanding problem statements, weak mastery of basic concepts, procedural errors, and low learning motivation. In addition, learning that still focuses on procedural memorization makes it difficult for students to connect mathematics with real-life experiences (Berisha & Bytyqi, 2020; Kolar & Hodnik, 2021). Therefore, an innovative, context-based learning approach is needed to bridge this gap (Wathani et al., 2022; Yuliana et al., 2022).

Beyond pedagogical challenges, educational disparities between regions further exacerbate numeracy literacy issues in elementary schools. Schools in remote areas generally face shortages of competent teachers, lack adequate learning facilities, and have limited access to relevant curricula and teaching materials. One potential solution to these problems is the application of *microlearning*—a strategy that presents learning content in small, focused, and easily accessible units, typically in digital formats such as short videos, animations, or interactive modules.

Interactive e-modules function as systematically designed self-learning materials that help students achieve learning objectives through concise learning units. Their digital format includes audio, video, and interactive navigation components that allow users to actively engage with the learning material (Firdaus, Fadhilah, et al., 2024). The *microlearning* approach has been proven to improve concentration, foster learner autonomy, and provide flexibility in both classroom and independent learning (Hug, 2005; Bruck et al., 2012). Furthermore, e-modules based on microlearning can enhance student engagement and create more enjoyable and meaningful learning experiences (Rahmawati et al., 2023; Rofiah et al., 2024).

Based on the above background, this study aims to: (1) analyze the current condition of numeracy literacy learning among elementary students within the context of the *Merdeka Curriculum* implementation, particularly regarding the approaches, media, and methods used; and (2) identify the main challenges faced by teachers in developing numeracy teaching materials, including the limitations in utilizing digital media and learning innovations.Through these objectives, this study is expected to provide valuable insights into the development of innovative, digital-based teaching materials that can enhance numeracy literacy among elementary students and effectively support the implementation of the *Merdeka Curriculum*.

Methods

This study employed a qualitative descriptive method aimed at describing the numeracy learning process in elementary schools, identifying the needs of teachers and students for digital teaching materials, and analyzing the relevance of the microlearning approach in developing e-modules to enhance numeracy literacy. The research was conducted from January to March 2025 in five elementary schools located in Moyudan District, Sleman Regency, Yogyakarta Special Region. The research sites were selected purposively by considering schools that had implemented the *Merdeka Curriculum* and were equipped with technology-based learning facilities.

The participants comprised five fifth-grade mathematics teachers and approximately 83 fifth-grade students, selected through purposive sampling according to their direct involvement in numeracy learning activities. Data were collected using three primary techniques: (1) classroom observation, to obtain a comprehensive understanding of the numeracy learning process; (2) semi-structured interviews, to explore teachers' conceptions of numeracy, their use of digital media, the challenges they face, and their perceived needs for teaching materials; and (3) documentation, including classroom photos, field notes, and relevant instructional materials. The research instruments consisted of observation sheets and interview guides developed based on numeracy indicators and aspects of technology integration in education. These instruments were conceptually validated through expert judgment prior to their implementation in the field.

Data were analyzed using the interactive analysis model proposed by Miles and Huberman (1994), which includes three stages: data reduction, data display, and conclusion drawing/verification. Data reduction involved organizing and focusing on essential information; data display was presented in the form of descriptive narratives and matrices; and conclusion drawing was carried out continuously with iterative verification to ensure the accuracy and consistency of findings.

To maintain data validity and credibility, triangulation of sources and methods was applied by cross-verifying the results from observations, interviews, and documentation. All research procedures adhered to established ethical research standards, including obtaining formal permission from schools, securing informed consent from participants, maintaining the confidentiality of respondents' identities, and ensuring that all collected data were used exclusively for academic and scientific purposes. The data analysis procedure is illustrated in Figure 1 below.

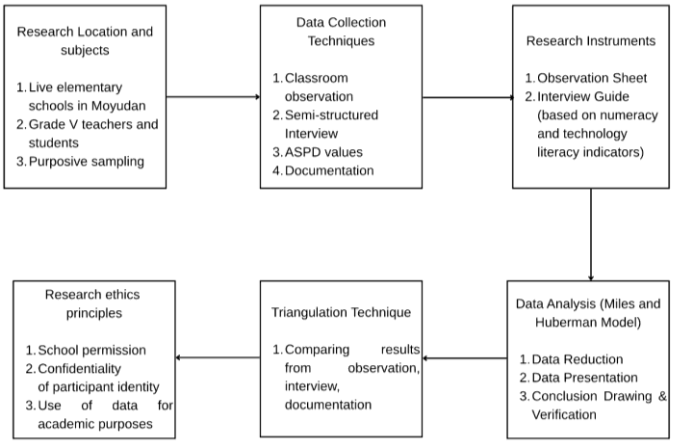

Figure 1. Analysis Procedure

Results and Discussion

Results

The results of a preliminary study conducted in five elementary schools in the Yogyakarta District area revealed various dynamics that reflect the complexity of implementing numeracy learning in the context of the Independent Curriculum. Based on direct observations in class and in-depth interviews with educators, it was identified that the numeracy learning process still tends to stagnate in a traditional framework, marked by the dominance of an expository approach, lack of use of contextual digital media,

and minimal innovation in presenting materials. This phenomenon indicates a discrepancy between the spirit of curriculum transformation and actual instructional practices in the classroom. The findings are further supported by the results of the ASPD, which can be summarized in the following table.

Table.1 ASPD

Description	School 1	School 2	School 3	School 4	School 5	Number	Overall Average
Number of students	16 students	12 students	29 students	14 students	12 students	83 students	-
Average Literacy Numeracy	52.29	55.28	51.26	49.52	47.78	203.84	51.226
The highest score	86.67	80.00	83.33	80.00	66.67	310	79.334
Lowest Value	36.67	33.33	23.33	26.67	23.33	106.66	28.666
Mode	50.00	53.33	40.00	53.33	50.00	196.66	49.332

Data from the *Asesmen Standar Pendidikan Daerah* (ASPD) provided further evidence of this gap. The average numeracy literacy score across the five schools was 51.23, below the minimum competency standard for primary education. School 2 recorded the highest average (55.28), while School 5 had the lowest (47.78). The score disparity between the highest (86.67 in School 1) and the lowest (23.33 in Schools 3 and 5) indicates a substantial inequality in students' numeracy mastery. The mode scores ranged between 40.00 and 53.33, with Schools 2 and 4 showing the highest mode (53.33), while School 3 had the lowest (40.00). This distribution suggests that most students remain within the low to moderate range, struggling not only with basic arithmetic skills but also with applying these skills to contextual problem-solving.

Three major points can be drawn from these data: (1) students' numeracy ability remains basic and procedural. Students are generally capable of performing arithmetic operations but face difficulties when required to apply their knowledge in real-life contexts. This highlights the need for stronger conceptual understanding and mathematical reasoning to support transfer and problem-solving abilities (Arifin et al., 2020). This finding aligns with the National Council of Teachers of Mathematics (NCTM, 2020), which emphasizes that numeracy extends beyond computation to include reasoning, problem formulation, and application in meaningful situations. Moreover, numeracy learning is closely related to students' daily experiences (Rahayu & Firdaus, 2025). Theoretically, this study contributes by integrating learning motivation (affective aspect) and problem-solving ability (cognitive aspect) as predictors of mathematical disposition among elementary students. Strong problem-solving skills are associated with a more positive mathematical disposition (Anggraeni et al., 2025); (2) there exists a significant achievement gap among students. The variation in numeracy outcomes reflects persistent inequality in learning results. Internal factors include differences in learning strategies, learning styles, and motivation. Ha et al., (2025) found that self-regulated motivation, particularly intrinsic regulation, significantly affects literacy and mathematics performance, underscoring the importance of cognitive and emotional factors in academic achievement. External factors involve access to learning resources, parental support, and school environment. Likewise, (Kurejsepi et al., 2025; Mues et al., 2022; Srinivas et al., 2025) highlighted that home learning environments, parental involvement, numeracy-related activities, and parents' beliefs about mathematics shape children's numeracy development. Thus, the disparity in numeracy outcomes results from a complex interplay between internal and external factors rather than individual ability alone; and (3) a more contextual and adaptive learning approach is needed. The findings show that most classrooms remain teacher-centered with limited use of technology or contextual tasks. Indonesian students often struggle to apply mathematical concepts in everyday problem situations, reflecting the dominance of procedural over conceptual learning (Fauzan et al., 2024; Putri et al., 2025).

Teacher interviews confirmed an urgent need to strengthen numeracy as a core 21st-century competency. However, teachers face several challenges, including limited instructional time, insufficient training in technology integration, and a lack of accessible and relevant digital teaching materials. As one teacher stated: "We try to help students not only calculate but also understand the concepts and explain their reasoning. However, due to limited instructional time and insufficient digital

media training, available materials often focus only on procedural steps. We hope for more interactive and student-centered teaching resources."

This statement illustrates that teachers are making genuine efforts to enhance numeracy learning despite existing resource constraints. These findings are consistent with (Buabeng & Amo-Darko, 2025; Dikdik et al., 2025), who emphasize that curriculum reform success depends on teacher readiness, which must be supported through sustained professional development. Effective PD programs not only improve pedagogical competence and reflective capacity but also ensure continuous quality improvement in teaching practices. Without such support, the implementation of the *Merdeka Curriculum* risks being suboptimal, especially in fostering higher-order thinking skills among students.

Microlearning offers an innovative solution to address the increasing complexity and diversity of instructional needs. Through its flexible, adaptive, and interactive design, microlearning has been shown to improve learning performance, knowledge retention, and learner engagement (Alias & Razak, 2024; Balasundaram et al., 2024; Monib et al., 2024). However, the success of microlearning depends heavily on sound pedagogical design and effective technology integration. Microlearning provides concise, focused, and easily digestible content that enhances retention and understanding (Hatamian, 2024). Moreover, it supports flexibility, personalization, and repetition aligned with the cognitive characteristics of elementary students. Silva et al. (2025) asserts that digital microlearning effectively connects learning to real-life experiences, making content more relevant and meaningful.

In the context of numeracy literacy, microlearning-based e-modules can integrate the four key dimensions of numeracy-formulate, employ, interpret, and evaluate (OECD, 2019). Short contextual videos can stimulate students to formulate problems; interactive simulations can facilitate the application of problem-solving strategies; and reflective visual narratives can help students interpret and evaluate their learning outcomes. Consequently, numeracy learning becomes less linear and mechanical, and more exploratory, interactive, and meaningful.

The findings indicate that numeracy learning in elementary schools remains dominated by traditional approaches, resulting in low achievement and significant disparities among students. Teachers' challenges in digital integration exacerbate this condition. Nevertheless, the development of microlearning-based e-modules is both relevant and urgent as an innovative pedagogical solution.

Theoretically, these results support constructivist learning theory, which emphasizes students' active engagement in constructing knowledge through real-world interaction and contextual learning. Constructivist principles are also reflected in problem-based learning models integrated with local culture, emphasizing authentic experience, collaboration, and the teacher's role as a facilitator guiding exploration and reflection (Hastomo, 2024; Rofiah et al., 2024).

Moreover, microlearning aligns with Cognitive Load Theory (Sweller, 1988), as it segments information into small, manageable units, reducing extraneous load and enhancing comprehension. This approach is also consistent with the 21st-century skills framework, which demands adaptability, critical thinking, and creativity. Therefore, this preliminary study provides both empirical evidence and theoretical justification that the development of microlearning-based e-modules is not only relevant but also essential to transform numeracy learning from traditional, monotonous instruction into dynamic, interactive, and contextually meaningful experiences.

Discussion

The first informant, an experienced educator with over 15 years in the field, demonstrated a strong ability to foster pedagogical closeness with students through a humanistic approach. He prioritized the needs, interests, and characteristics of his students, creating a motivating and supportive learning environment while strengthening interpersonal relationships (Widjajanti, 2019). This approach emphasizes the personal and moral development of students and aligns with Bulkani et al. (2025) perspective on holistic education, which encompasses physical, mental, social, emotional, and spiritual aspects. This comprehensive focus encourages active participation and the overall growth of students.

Educators also show a high awareness of the importance of numeracy literacy as a foundation in forming students' logical thinking and problem-solving skills. According to him, numeracy literacy not only supports academic skills but also plays a crucial role in daily decision-making. He emphasized that numeracy skills are not just technical skills, but are closely related to the ability to think critically, evaluate information objectively, and make appropriate and rational decisions. This view is in line with

the literature that places numeracy literacy as a pillar in developing systematic reasoning strategies and reflective thinking skills (Getenet, 2022; Ghazali & Ashari, 2020). Numeracy literacy enables students to understand data, interpret quantitative information, and use it in real world contexts meaningfully (Adelia et al., 2024).

Educators acknowledge the limitations in integrating digital technology into learning practices. Many teachers, including themselves, face challenges in terms of technical skills, making it difficult to optimally utilize digital resources in the teaching process (Aagaard et al., 2024). Most numeracy materials are still delivered conventionally due to limitations in designing and operating technology based learning media. These limitations are a separate obstacle amidst the demands of the Merdeka Curriculum which increasingly encourages digital transformation in education. In fact, the edutainment approach such as the use of educational music videos, animations, or interactive games has been proven effective in increasing student motivation, interest in learning, and engagement, especially at the elementary education level (Othman et al., 2022).

Previous literature supports the effectiveness of utilizing digital technology in learning, especially in improving the quality of learning processes and outcomes. The development of tools such as interactive video players, animation-based media, and audiovisual content has been shown to strengthen students' understanding of the subject matter while creating a fun and meaningful learning atmosphere (Coccoli et al., 2024). In the context of mathematics education, the use of interactive technology not only contributes to improving academic achievement but also fosters mathematical communication skills and deepens students' understanding of abstract concepts (Pasani, 2025b) This fact shows that technology integration can be a strategic means of realizing more participatory and contextual learning. Therefore, the gap between educators' awareness of the potential of technology and their technical skills needs to be bridged through training programs that are sustainable, practical, and relevant to the needs of 21st-century learning.

Educators see microlearning-based e-modules as a promising solution to enhance digital learning. E-modules that are designed to be simple, intuitive, and require minimal technical skills have significant potential for successful implementation by both teachers and students. Research by Balasundaram et al. (2024) supports this view, showing that user-friendly interface design in microlearning e-modules can enhance students' focus, conceptual understanding, and information retention. Additionally, Santosa et al. (2025) emphasize that e-modules should be designed for independent use by students, eliminating the need for intensive technical training. This aspect of independence is particularly crucial in the context of hybrid and distance learning, where students must manage their own learning effectively.

The second informant is a young educator with less than ten years of teaching experience, but he demonstrates a strong enthusiasm for using technology in learning. He has experimented with various digital platforms and has created simple content using PowerPoint and Canva. Research has shown that interactive visual communication design and multimedia can significantly improve learning outcomes across cognitive, affective, and psychomotor domains (Nurkanti & Angraeni, 2022). However, educators have reported challenges in aligning the content they create with the numeracy learning outcomes outlined in the Merdeka Curriculum. In practice, the second informant utilized PowerPoint and Canva in a complementary manner. This aligns with findings by Ramos (2024), which indicate that PowerPoint can be enhanced with interactive multimedia elements, while Canva is effective for creating visually appealing supplementary materials.

Educators have observed that learners respond positively to visual and interactive learning methods (Dey & Munshi, 2025). These approaches have been shown to effectively increase motivation and engagement among students. However, there is a need for more systematic and ready-to-use teaching materials so that educators do not have to create everything from scratch. Moreover, the second informant noted that the microlearning approach is particularly well-suited to the learning styles of today's students, who tend to lose focus quickly and prefer content that is brief, clear, and engaging. This method accommodates various learning styles, including visual, auditory, and kinesthetic, making it especially beneficial for students who struggle with traditional teaching methods (Ngatirin & Zainol, 2021). Additionally, microlearning is considered an innovative educational methodology that meets learning needs in the digital era. It provides concise and easily accessible content, which can enhance student autonomy and motivation to learn (Verdesoto & Caicedo, 2025).

The third informant exhibited a conservative approach to learning but expressed openness to innovation when it was accompanied by intensive support. While educators acknowledge the importance

of numeracy literacy, it is often narrowly interpreted as merely the ability to count. This limited perspective can impede the development of comprehensive numeracy skills (Adelia et al., 2024). In practice, educators tend to rely on textbooks, student worksheets, and practice questions, rarely utilizing digital media, which they perceive as less efficient due to a lack of familiarity. This attitude reveals a resistance to change among teachers, generally stemming from low self-confidence in using technology (Schiefner-Rohs & Krein, 2023).

Educators noted that students often struggle with understanding word problems because they are not accustomed to connecting real-world contexts with mathematical concepts involving multiples. This aligns with findings that indicate a weak ability to model situations is a primary cause of these difficulties (Gabrel & Laura, 2024). To address this issue, informants suggested the creation of contextual e-modules that offer step-by-step exercises based on everyday experiences, along with practical guides for educators. This recommendation supports the development of interactive e-modules aimed at effectively enhancing student numeracy (Getenet, 2024; Nurin et al., 2024).

The fourth informant demonstrated a reflective teaching style and exhibited a strong awareness of the diverse characteristics and learning needs of students in the classroom. He understood that a single educational approach was insufficient to address the varied learning styles of all students. Generally, students' learning styles can be classified into four main categories: visual, auditory, reading/writing, and kinesthetic (Ngatirin & Zainol, 2021). Recognizing this diversity motivated the informants to integrate a variety of learning strategies, making their teaching more inclusive and responsive to the individual needs of students. This perspective aligns with Alali et al. (2024), who emphasized that no single learning theory can fully address the complexities of the teaching and learning process; therefore, teachers must utilize a combination of different learning approaches.

Informants have reported using visual media, such as self-created images and videos, in their learning activities. The use of multimedia is deemed effective because it engages various learning styles simultaneously, including visual, auditory, and kinesthetic (Stanković et al., 2018). This perspective is supported by Meriza et al. (2024), who highlight the importance of implementing differentiated learning, particularly in the area of numeracy. This approach allows each student to develop according to their abilities and pace. Additionally, informants recognize the significant potential of a modular and flexible microlearning approach, which empowers students to learn at their own rhythm and according to their capabilities. They emphasize that the success of microlearning heavily depends on the design of content and teaching materials, which should be engaging and easy for students to understand.

The content that is developed must have a strong visual appeal and be presented through a narrative that is relevant to the world of children. This aligns with the findings of Blinov et al. (2022) and Zambrano Verdesoto & Caicedo, (2025), who highlighted that the success of microlearning implementation depends on three main factors: (1) the quality and design of learning content; (2) the readiness and capability of the technology used; and (3) the suitability of the approach to the educational context in schools. Additionally, one important expectation for the development of microlearning-based e-modules is the availability of adaptive learning paths that cater to individual student needs. These modules should present numeracy material in a visually engaging format and contextual narrative, allowing students to develop a deeper and more meaningful understanding.

The Fifth Informant expressed significant concern for students' cognitive and social development. Educators observed that the current approach to numeracy literacy learning had failed to spark students' curiosity. So far, this approach has been too procedural and has not effectively engaged students (Meriza et al., 2024; Winarni et al., 2025). To address this issue, educators attempted to incorporate open-ended questions and multiple-based games, but they struggled to integrate these methods systematically. They found that students showed great enthusiasm when learning through storytelling, logic challenges, or game-based quizzes. This approach is believed to enhance motivation and improve learning outcomes by providing interactive and enjoyable experiences (Campillo-Ferrer et al., 2020).

Educators encourage the development of microlearning-based e-modules that combine narratives, visuals, and simple yet meaningful activities to create a fun numeracy learning experience. The findings of Firdaus et al. (2024) showed that interactive e-modules, such as the Iguanas e-book, were more effective than traditional textbooks in improving students' numeracy skills. The support of digital technology allows for interactive presentation of materials, personalization of learning, and continuous formative evaluation. Alyusfitri et al. (2024) also found that interactive multimedia e-modules had a significant impact on learning outcomes and received positive responses from students.

Conclusion

This study concludes that integrating microlearning-based e-modules into numeracy education in elementary schools has significant potential to address various challenges faced by teachers and students in the classroom. Qualitative data collected from observations, interviews, and documentation revealed that while most teachers acknowledged the importance of numeracy, they often viewed it narrowly as just a counting skill. Additionally, learning practices tended to be procedural and limited in their use of real-world contexts and digital media.

The findings of this study indicate that students respond positively to learning strategies that incorporate stories, games, and real-life contexts. Teachers have highlighted the need for adaptive and engaging learning materials that accommodate diverse learning styles, reduce instructional rigidity, and enhance students' understanding of mathematics through meaningful experiences. This study underscores the urgency of developing e-modules that are modular, flexible, and rich in context to support differentiated learning and improve numeracy skills. Theoretically, it contributes to the discussion on digital learning innovation by demonstrating that microlearning can be used to personalize and modernize the teaching of basic mathematics. Practically, the study recommends creating e-modules that include visual media, simple activities, interactive features, and user-friendly guides for teachers. These resources should align with the principles of the Merdeka Curriculum. Additionally, further research is encouraged to conduct trials and evaluations of these e-modules across various educational contexts to assess their effectiveness and scalability.

References

Aagaard, T., Amdam, S. H., Nagel, I., Vika, K. S., Andreasen, J. K., Pedersen, C., & Røkenes, F. M. (2024). Teacher preparation for the digital age: Is it still an instrumental endeavor? *Scandinavian Journal of Educational Research*, *69*(3), 651–665. DOI: https://doi.org/10.1080/00313831.2024.2330927

Abidin, Z., Herman, T., Farojah, L., Febriandi, R., & Penehafo, A. E. (2022). Why did elementary students have difficulty working in mathematical literacy questions? *ELEMENTARY: Islamic Teacher Journal*, *10*(1), 121. DOI: https://doi.org/10.21043/elementary.v10i1.14006

Adelia, V., Putri, R. I. I., & Zulkardi. (2024). A systematic literature review: How do we support students to become numerate? *International Journal of Evaluation and Research in Education*, *13*(3), 1816–1824. DOI: https://doi.org/10.11591/ijere.v13i3.26849

Afifah, D. S. N., Nafi'an, M. I., & Manggar, D. A. (2023). The development of Adobe Flash CS6-based interactive media to improve numerical literacy skills for Madrasah Ibtidaiyah students. *Kreano: Jurnal Matematika Kreatif-Inovatif*, *14*(1), 75–85. DOI: https://doi.org/10.15294/kreano.v14i1.38825

Alali, N. N., Carson, H. J., & Collins, D. (2024). A pragmatic approach to skill acquisition for physical education: Considering cognitive and ecological dynamics perspectives. *Quest*, *76*(2), 227–246. DOI: https://doi.org/10.1080/00336297.2023.2298931

Alias, N. F., & Razak, R. A. (2024). Malaysian journal of learning. *Malaysian Journal of Learning and Instruction*, *21*(1), 217–247. DOI: https://doi.org/10.32890/mjli2023.20.2.3

Alyusfitri, R., Gistituati, N., Yerizon, Fauzan, A., & Yarman. (2024). The effectiveness and relationship of student responses toward learning outcomes using interactive multimedia-based e-modules in elementary schools. *International Electronic Journal of Elementary Education*, *16*(5), 573–584. DOI: https://doi.org/10.26822/iejee.2024.354

Anggraeni, U., Amir, M. F., & Wardana, M. D. K. (2025). How can learning motivation and problem-solving predict the mathematical disposition of primary students? *Jurnal Prima Edukasia*, *13*(2), 375–388. DOI: https://doi.org/10.21831/jpe.v13i2.83008

Arifin, S., Wahyudin, W., & Herman, T. (2020). The effects of contextual group guided discovery learning on students' mathematical understanding and reasoning. *Jurnal Prima Edukasia*, *8*(2), 106–114. DOI: https://doi.org/10.21831/jpe.v8i2.33059

Ayuningtyas, I. N., Amir, M. F., & Wardana, M. D. K. (2024). Elementary school students' layers of understanding in solving literacy problems based on Sidoarjo context. *Infinity Journal*, *13*(1), 157–174. DOI: https://doi.org/10.22460/infinity.v13i1.p157-174

Balasundaram, S., Mathew, J., & Nair, S. (2024). Microlearning and learning performance in higher education: A post-test control group study. *Journal of Learning for Development*, *11*(1), 1–14. DOI: https://doi.org/10.56059/jl4d.v11i1.752

Berisha, V., & Bytyqi, R. (2020). Types of mathematical tasks used in secondary classroom instruction. *International Journal of Evaluation and Research in Education*, *9*(3), 751–758. DOI: https://doi.org/10.11591/ijere.v9i3.20617

Blinov, V. I., Sergeev, I. S., & Rodichev, N. F. (2022). The microlearning – from business to education: A promising direction for the development of didactics. *Obrazovanie i Nauka*, *24*(9), 43–68. DOI: https://doi.org/10.17853/1994-5639-2022-9-43-68

Buabeng, I., & Amo-Darko, B. (2025). Curriculum reforms without foundation: The effects of inadequate preparation in curriculum reforms on Ghanaian teachers and the education system. *Curriculum Perspectives*, *45*(2), 133–147. DOI: https://doi.org/10.1007/s41297-025-00309-7

Bulkani, B., Riadin, A., Ni'mah, N., & Setiawan, M. A. (2025). Impact of holistic learning models on character development: A systematic review. *Obrazovanie i Nauka*, *27*(5), 111–141. DOI: https://doi.org/10.17853/1994-5639-2025-5-111-141

Campillo-Ferrer, J. M., Miralles-Martínez, P., & Sánchez-Ibáñez, R. (2020). Gamification in higher education: Impact on student motivation and the acquisition of social and civic key competencies. *Sustainability*, *12*(12), 4822. DOI: https://doi.org/10.3390/su12124822

Coccoli, M., Torre, I., & Galluccio, I. (2024). User experience evaluation of Edurell interface for video augmentation. *Multimedia Tools and Applications*, *83*(12), 36695–36717. DOI: https://doi.org/10.1007/s11042-023-15912-x

Dey, A., & Munshi, S. A. (2025). Fun with images: An analysis of the role of visual literacy in facilitating easy and enjoyable learning with a focus on future prospects. *Libri*, 1–19. DOI: https://doi.org/10.1515/libri-2024-0143

Dikdik, A., Suryana, A., Triana, C., Rahyasih, Y., & Oktaviani, F. F. (2025). Improving teachers' numeracy skills at Cisarua State Elementary School, West Java, Indonesia. *Jurnal Prima Edukasia*, *13*(1), 111–127. DOI: https://doi.org/10.21831/jpe.v13i1.82453

Fauzan, A., Harisman, Y., Yerizon, Suherman, Tasman, F., Nisa, S., Sumarwati, Hafizatunnisa, & Syaputra, H. (2024). Realistic Mathematics Education (RME) to improve literacy and numeracy skills of elementary school students based on teachers' experience. *Infinity Journal*, *13*(2), 301–316. DOI: https://doi.org/10.22460/infinity.v13i2.p301-316

Firdaus, F. M., Fadhilah, N., Wuryandari, I. T., & Fadhli, R. (2024). Liveworksheet interactive e-module effect on equal fractions comprehension at 4th grade elementary school. *Jurnal Prima Edukasia*, *12*(1), 156–164. DOI: https://doi.org/10.21831/jpe.v12i1.64526

Firdaus, F. M., Safitri, A. D., Amanah, D. N., Fadhli, R., & Hassan, N. M. (2024). Evaluating the effectiveness of the iPusnas in enhancing elementary students' numeracy skills. *Record and Library Journal*, *10*(1), 93–102. DOI: https://doi.org/10.20473/rlj.V10-I1.2024.93-102

Getenet, S. (2024). Understanding how pre-service teachers design numeracy-rich activities in non-

mathematic curriculum areas. *Journal of Research in Innovative Teaching & Learning*. DOI: https://doi.org/10.1108/JRIT-05-2024-0124

Getenet, S. T. (2022). Teachers' knowledge framework for designing numeracy rich tasks across non-mathematics curriculum areas. *International Journal of Education in Mathematics, Science and Technology*, *10*(3), 663–680. DOI: https://doi.org/10.46328/ijemst.2137

Ghazali, M., & Ashari, Z. M. (2020). Development of a framework to assess preschool children's numeracy. *Journal of Physics: Conference Series*, *1460*(1), 012002. DOI: https://doi.org/10.1088/1742-6596/1460/1/012002

Ha, C., Zhang, Q., & Roehrig, A. D. (2025). Early adolescents' motivational regulation and academic achievement: Using multi-level modeling analysis based on self-determination theory. *Social Psychology of Education*, *28*(1). DOI: https://doi.org/10.1007/s11218-024-10013-5

Hastomo, A. (2024). The development of educational practice lecture models to prepare adaptive and innovative 21st-century primary school teachers. *Jurnal Prima Edukasia*, *12*(2), 177–182. DOI: https://doi.org/10.21831/jpe.v12i2.51053

Hatamian, M. (2024). Supplementary learning: Toward enriching microlearning from a design perspective. *Proceedings of International Conference on Smart Systems and Technologies (SST 2024)*, 77–82. DOI: https://doi.org/10.1109/SST61991.2024.10755267

Hurst, C. (2007). Improving mathematical learning through contextualisation. *AARE Annual Conference*. https://www.aare.edu.au/data/publications/2007/hur07221.pdf

Kolar, V. M., & Hodnik, T. (2021). Mathematical literacy from the perspective of solving contextual problems. *European Journal of Educational Research*, *10*(1), 467–483. DOI: https://doi.org/10.12973/eu-jer.10.1.467

Kurejsepi, E., Jusufi, J., Mujo, D., Dilji, A., Pupe, E., & Skenderi, N. (2025). Misalignment of inter-curricular areas in the second stage of education in Kosovo. *Human Research in Rehabilitation*, *15*(2), 360–370. DOI: https://doi.org/10.21554/hrr.092510

Kurniawan, A., Kuswanto, H., Naba, S. D., & Syar, N. I. (2024). Trends of computational thinking research in science and technology area: A systematic literature review. *SCIENCE: Jurnal Inovasi Pendidikan Matematika Dan IPA*, *4*(4), 477–491. DOI: https://doi.org/10.51878/science.v4i4.3572

Meriza, D., Hiltrimartin, C., & Hartono, Y. (2024). Development of problem based differentiated learning comparison materials in junior high school. *Jurnal Pendidikan Matematika*, *18*(3), 447–468. DOI: https://doi.org/10.22342/jpm.v18i3.pp447-468

Monib, W. K., Qazi, A., Apong, R. A., & Mahmud, M. M. (2024). Investigating learners' perceptions of microlearning: Factors influencing learning outcomes. *IEEE Access*, *12*, 178251–178266. DOI: https://doi.org/10.1109/ACCESS.2024.3472113

Moro R. S. (2024). Canva as a tool to promote meaningful learning in the teaching of English as a foreign language. *European Public and Social Innovation Review*, *9*. DOI: https://doi.org/10.31637/EPSIR-2024-869

Mues, A., Wirth, A., Birtwistle, E., & Niklas, F. (2022). Associations between children's numeracy competencies, mothers' and fathers' mathematical beliefs, and numeracy activities at home. *Frontiers in Psychology*, *13*, 835433. DOI: https://doi.org/10.3389/fpsyg.2022.835433

Murtafiah, W., Setyansah, R. K., & Nurcahyani, D. A. (2021). Kemampuan komunikasi matematis dalam menyelesaikan circle problem berdasarkan self-confidence siswa SMP. *Jurnal Elemen*, *7*(1), 130–145. DOI: https://doi.org/10.29408/jel.v7i1.2785

Ngatirin, N. R., & Zainol, Z. (2021). Automatic detection of learning styles: A decade review on data-driven approaches. *Journal of Physics: Conference Series*, *1997*(1), 012001. DOI: https://doi.org/10.1088/1742-6596/1997/1/012001

Nurin, N. S., Junaedi, I., & Cahyono, A. N. (2024). Learning numeracy around school environment supported by mobile math trails using problem-based learning model. *Jurnal Pendidikan Matematika*, *18*(3), 485–498. DOI: https://doi.org/10.22342/jpm.v18i3.pp485-498

Nurkanti, M., Riandi, & Putri, D. (2022). The improvement of student's learning outcome on. *AIP Conference Proceedings*, *2638*(1), 060008. DOI: https://doi.org/10.1063/5.0115708

Pasani, C. F., & Amelia, R. (2025). Smart mobile technologies in math education. *International Journal of Interactive Mobile Technologies*, *19*(7), 159–177. DOI: https://doi.org/10.3991/ijim.v19i07.51921

OECD. (2019). *OECD Learning Framework 2030*. Springer.

Othman, H. S., Zaibon, S. B., & Abidin, A. H. Z. (2022). The significance of edutainment concept in video-based learning in proposing the elements of educational music video for children's learning. *International Journal of Interactive Mobile Technologies*, *16*(5), 91–106. DOI: https://doi.org/10.3991/ijim.v16i05.23711

Putri, D. A. P., Fatmawati, A., Haryanti, Y., Minalloh, A. N., & Wijaya, P. P. (2025). Development of an augmented reality mobile application for interactive geometry learning in children. *Proceedings of the 22nd International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology (ECTI-CON 2025)*. DOI: https://doi.org/10.1109/ECTI-CON64996.2025.11101056

Rahayu, W. N., & Firdaus, F. M. (2025). Increased motivation and ability student numeracy through the application of a contextual approach to mathematics learning. *Jurnal Prima Edukasia*, *13*(2), 361–374. DOI: https://doi.org/10.21831/jpe.v13i2.75555

Rahmawati, R. D., Sulistyani, N., Purnomo, Y. W., Fitriya, Y., & Ramadhani, D. (2023). Relationship between elementary school students' numeracy and number sense. *The New Educational Review*, *74*, 73–88. DOI: https://doi.org/10.15804/tner.23.74.4.06

Rakhmawati, Y., & Mustadi, A. (2022). The circumstances of literacy numeracy skill: Between notion and fact from elementary school students. *Jurnal Prima Edukasia*, *10*(1), 9–18. DOI: https://doi.org/10.21831/jpe.v10i1.36427

Rofiah, N. H., Restiana, R., & Dewi, R. (2024). Promoting digital literacy: Assessing teachers readiness in utilizing information and communication technology for learning in rural area. *Jurnal Prima Edukasia*, *12*(1), 41–51. DOI: https://doi.org/10.21831/jpe.v12i1.63968

Sa'diyah, M., Sa'dijah, C., & Susiswo, S. (2024). Students' ability to formulate situation mathematically from context-based mathematics problems. *TEM Journal*, *13*(2), 1443–1451. DOI: https://doi.org/10.18421/TEM132-58

Santosa, I., Iskandar, I., & Setiadi, S. (2025). Adapting language learning materials for digital native: Infusing CEFR standards in English procedural texts on microlearning apps. *World Journal of English Language*, *15*(4), 171–183. DOI: https://doi.org/10.5430/wjel.v15n4p171

Schiefner-Rohs, M., & Krein, U. (2023). Media-related practices of student teachers: Insights from a student perspective. *Unterrichtswissenschaft*, *51*(4), 623–642. DOI: https://doi.org/10.1007/s42010-023-00187-w

Silva, E. S., Costa, W. P. da, Lima, J. C. de, & Ferreira, J. C. (2025). Contribution of microlearning in basic education: A systematic review. *Education Sciences*, *15*(3), 302. DOI:

https://doi.org/10.3390/educsci15030302

Srinivas, K., Bhattacharyya, H., Banoo, H., Touthang, N., & Bika, S. L. (2025). Parental support for foundational literacy and numeracy skills among schoolchildren: A case study from India. *Social Sciences & Humanities Open*, *12*, 101998. DOI: https://doi.org/10.1016/j.ssaho.2025.101998

Stanković, Z., Maksimović, J., & Osmanović, J. (2018). Cognitive theories and paradigmatic research posts in the function of multimedia teaching and learning. *International Journal of Cognitive Research in Science, Engineering and Education*, *6*(2), 107–114. DOI: https://doi.org/10.5937/ijcrsee1802107S

Suharja, S., Mustadi, A., & Oktari, V. (2024). Examining the brain-based learning model assisted by an open-ended approach to understanding mathematical concepts. *Jurnal Prima Edukasia*, *12*(1), 19–29. DOI: https://doi.org/10.21831/jpe.v12i1.67303

Susanta, A., Sumardi, H., Susanto, E., & Retnawati, H. (2023). Mathematics literacy task on number pattern using Bengkulu context for junior high school students. *Journal on Mathematics Education*, *14*(1), 85–102. DOI: https://doi.org/10.22342/jme.v14i1.pp85-102

Suwandayani, B. I., Fakhruddin, Y., & Astutik, L. S. (2020). Implementation of the numeracy literacy program in learning mathematics remaining Class IV in Muhammadiyah elementary schools. *Proceeding International Webinar On Education 2020*, 285–293.

Verdesoto, G. J. Z., & Caicedo, M. F. (2025). The importance of microlearning in higher education. *European Public and Social Innovation Review*, *10*, 1–14. DOI: https://doi.org/10.31637/epsir-2025-2075

Vitantri, C. A., & Syafrudin, T. (2022). Kemampuan literasi matematika siswa sekolah dasar pada pemecahan masalah soal cerita. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *11*(3), 2108–2119. DOI: https://doi.org/10.21427/ajpm.v11i3.5091

Wathani, D. H., Irawati, R., & Iswara, P. D. (2022). Development of meme learning media with PMRI to implement mathematics literacy in students elementary school. *Jurnal Pendidikan Matematika*, *16*(3), 339–350. DOI: https://doi.org/10.22342/jpm.16.3.15249.339-350

Widjajanti, D. B. (2019). Making mathematics classes more humanistic. *Journal of Physics: Conference Series*, *1320*(1), 012096. DOI: https://doi.org/10.1088/1742-6596/1320/1/012096

Winarni, S., Kamid, Marzal, J., & Asrial. (2025). Numeracy skill development in prospective mathematics teachers: Challenges and opportunities in real-world contexts. *Journal on Mathematics Education*, *16*(1), 91–110. DOI: https://doi.org/10.22342/jme.v16i1.pp91-110

Yuliana, Y., Usodo, B., & Riyadi, R. (2022). The new way improve mathematical literacy in elementary school: Ethnomathematics module with realistic mathematics education. *AL-ISHLAH: Jurnal Pendidikan*, *15*(1), 33–44. DOI: https://doi.org/10.35445/alishlah.v15i1.2591