

The Impact of Learning Environments on Mathematics Outcomes and The Cultivation of Numeracy Literacy: A Literature Study

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INFO ARTICLES

Article History:

Received: 09-04-2026
Revised: 18-06-2026
Approved: 18-06-2026
Publish Online: 30-06-2026

Key Words:

Learning Environment; Numeracy Literacy; Mathematics Learning



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Abstract: This study examines the role of the learning environment in fostering numeracy literacy and mathematics learning outcomes through a student-centric perception. Addressing suboptimal numeracy achievements, this research highlights how physical, social, and digital environments serve as foundational elements for developing critical reasoning and mathematical problem-solving skills. A qualitative narrative literature review was conducted by retrieving articles from the Google Scholar database. Using the keywords “learning environment,” “numeracy literacy,” and “mathematics learning,” the search was limited to full-text publications from 2021 to 2026. Fifteen highly relevant articles were selected and analyzed through purposive thematic synthesis to construct a cohesive theoretical framework. The findings reveal that the learning environment significantly and consistently impacts mathematics achievement and numeracy literacy. Specifically, the social and emotional climate strongly dictates student readiness, with the reviewed literature demonstrating its dominant contribution over individual cognitive understanding. Furthermore, while physical facilities provide space for exploration, they require effective pedagogical management to directly improve academic outcomes. A key limitation is that the current literature predominantly focuses on primary education, highlighting a critical need for future empirical research in secondary school contexts. These findings imply that educators must design adaptive, comprehensive ecosystems to fully optimize mathematics learning.

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How to Cite (APA 6th Style): Wulandari S, R.P., Prihaswati, M., & Suprayitno, I.J. (2026). The Impact of Learning Environments on Mathematics Outcomes and The Cultivation of Numeracy Literacy: A Literature Study. *JKPM (Jurnal Kajian Pendidikan Matematika)*, 11 (2): 327-334. <https://doi.org/10.30998/jkpm.v11i2.3153>

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Competing Interests Disclosures: The authors declare that they have no significant competing financial, professional or personal interests that might have influenced the performance or presentation of the work described in this manuscript.

INTRODUCTION

Education today demands that students develop more than just rote memorization; they need critical, innovative, and reflective thinking skills to thrive in a complex world (Patriana et al., 2021a). Numeracy is a core competency in this regard, and it is primarily built through mathematics education. Rather than just performing basic calculations, true numeracy involves the ability to understand, interpret, and apply mathematical concepts to solve real-life problems (Rosalina & Suhardi, 2020). In our data-driven society, having strong numeracy skills is no longer optional; it is an essential requirement for active and informed participation (Díez-Palomar et al., 2023).

However, despite its importance, numeracy proficiency among Indonesian students remains a significant challenge (OECD, 2023). Recent Minimum Competency Assessment (AKM) results highlight that many students still struggle, especially when faced with complex problems that require advanced reasoning and data interpretation (Setianingsih et al., 2022). This aligns with findings by Fajriyah (2022), who noted that junior high school students often find it difficult to connect theoretical mathematical concepts with practical, everyday situations. This gap suggests that current teaching practices in mathematics may not yet be fully effective in nurturing these vital numeracy skills (Apipah et al., 2023).

There is a strong, reciprocal relationship between a student's overall mathematics achievement and their numeracy skills (Ningsih et al., 2022). Good performance in mathematics often indicates a student's readiness to apply numerical concepts to problem-solving. To build this foundation, cultivating a supportive educational setting is crucial for fostering a distinct numeracy culture (Oktaviana et al., 2022). The learning environment which encompasses physical, social, and psychological dimensions directly affects how well students engage with and understand the material (Prantauwati et al., 2021). Research consistently shows that a positive and conducive atmosphere boosts mathematics achievement (Agustina & Masyithoh, 2025), while a poor climate can hinder motivation and learning (Susanto & Anggresta, 2024). Therefore, strategically optimizing the learning environment is a key approach to improving mathematics instruction and advancing numeracy capabilities (Sutrimo et al., 2024).

Previous studies have shown that learning environments significantly affect general mathematics outcomes (Prantauwati et al., 2021). For instance, Abbas & Rizki (2023) discovered that a supportive learning environment significantly influences the academic achievement of junior high school students in mathematics. Similarly, Ibadi et al. (2025) revealed that the quality of the socio-emotional climate within classrooms substantially bolsters student engagement in the learning process. However, research focusing specifically on how these environments cultivate numeracy skills is still limited (Shabrina, 2022). Improving numeracy depends not just on teaching methods or materials, but on the dynamics of the entire learning ecosystem (Prawidia & Khusna, 2021a). A supportive atmosphere encourages reflective thinking, improves problem-solving, and helps students develop a positive attitude toward mathematics (Ayu & Dianariska, 2024). Understanding exactly how the environment shapes these outcomes is essential for educators, researchers, and curriculum developers (Patriana et al., 2021).

Therefore, this literature review aims to explore how various dimensions of the learning environment impact mathematics achievement and, subsequently, foster numeracy literacy. By synthesizing recent studies, this paper seeks to provide a holistic overview of the physical, social, and pedagogical factors that support student success. Ultimately, this review aims to establish a solid theoretical framework to guide future empirical research across different educational levels.

METHOD

This study employs a Narrative Literature Review approach. As noted by Baethge et al. (2019), a narrative review offers a practical, qualitative way to synthesize diverse literature and make sense of complex educational issues. Instead of relying on strict algorithmic filtering typical of systematic reviews, this method allows researchers to thoughtfully group themes to build a clear theoretical

framework (Snyder, 2019). Guided by this methodology, the review addresses three main questions: (1) Which specific aspects of the learning environment impact math outcomes and numeracy skills, particularly when viewed from a student-centric perspective? (2) How do these environments actively support the development of these skills? and (3) What can we learn from previous research to design better, adaptive mathematics instruction?

To gather data, academic articles were retrieved from the Google Scholar database using the Publish or Perish application (Rohimah, 2025). The search relied on specific keywords, namely “learning environment” and “numeracy literacy.” We applied specific criteria to ensure the sources were relevant and up-to-date. The selection was limited to full-text national and international articles published between 2021 and 2026 that directly discussed learning environments and numeracy. Any publications falling outside this scope or published before 2021 were excluded from the analysis.

After collecting the articles, we conducted a data reduction and inventory process. Each paper was carefully reviewed to confirm its alignment with the study's primary objectives. The selected articles were then analyzed using thematic synthesis (Mengist et al., 2020). This step involved identifying recurring themes and key findings regarding learning environments and numeracy, and organizing them into distinct clusters. Through this structured approach, the review successfully presents an evidence-based picture of the current pedagogical landscape in mathematics education.

RESULTS

Based on the literature review process, 15 primary articles were identified as the most relevant for in-depth qualitative analysis. These articles comprehensively demonstrate how the quality of the learning environment provides crucial opportunities for fostering students' numeracy literacy skills. A summary of the key findings from these ten primary articles is presented in Table 1.

Table 1. Analysis Results of the 10 Primary Articles

No	Title	Researchers	Key Findings
1	Strengthening Numeracy Literacy Through Physical Environments in Elementary Schools	(Rizal et al., 2024)	Direct experience and visual-based approaches are effective in enhancing the understanding of basic mathematical concepts.
2	The Importance of Mathematical Literacy Skills in Mathematics Learning	(Hayati & Jannah, 2024)	Numeracy literacy fosters critical thinking and problem-solving; an active and interactive learning environment strengthens students' mathematical literacy.
3	The Influence of Learning Environment Atmosphere and Student Interest on Mathematics Learning Outcomes	(Prawidia & Khusna, 2021)	The learning atmosphere and student interest positively impact focus and motivation, contributing 32.3% significantly to mathematics learning outcomes.
4	Cultivating Numeracy Literacy in Core Mathematics Learning Activities in Junior High Schools	(Rahmayanti & Sutarna, 2022)	Cultivating numeracy requires student engagement and teacher creativity through controlled training methods, both individually and in groups.
5	Literature Review: The Role of Learning Environments in Improving Children's Literacy Skills	(Nugroho & Dewi, 2024)	Synergy across the "tri-center of education" (home, school, community) is crucial; cultivating good practices and innovative approaches effectively boosts literacy.
6	The Effect of Learning Environment Settings on	(Rizky et al., 2024)	While differences between indoor and outdoor settings do not significantly alter academic

No	Title	Researchers	Key Findings
	Elementary Students' Mathematics Academic Achievement		scores, outdoor learning markedly increases student motivation and engagement.
7	Does the Learning Environment Affect Students' Mathematics Achievement?	(Ayyubi et al., 2025)	The learning environment exerts a strong and significant influence on mathematics achievement, contributing 60.4% to supporting learning outcomes.
8	Learning Environment and Learning Facilities: Numeracy Literacy for Class V Elementary School Students during the Pandemic	(Efendi et al., 2023)	Both environment and facilities influence numeracy; however, facilities alone are insufficient without a supportive environmental management.
9	The Role of Learning Environments in Encouraging Active Participation of Elementary School Students	(Saleh, 2025)	Five key environmental aspects drive participation: interactive classroom layout, positive emotional climate, teacher as facilitator, innovative media, and inclusivity.
10	Developing Students' Literacy and Numeracy Skills in the School Environment	(Hamidah et al., 2025)	Project-based learning, a supportive school environment, and interactive media are highly effective in developing students' literacy and numeracy skills.

DISCUSSION

Analysis of the ten primary articles indicates that the learning environment plays a consistent and significant role in improving mathematics learning outcomes and fostering students' numeracy skills across various educational levels. Specifically, the literature findings can be categorized into three dimensions: the physical dimension, the socio-emotional dimension, and the learning ecosystem.

The physical dimension and school facilities

Focusing on the physical dimension, Rizal Mz et al. (2024) explain that the school's physical environment possesses great potential as a source of direct experience-based learning, which is effective for strengthening basic mathematical concepts and numeracy literacy. This is supported by Hamidah et al. (2025), who state that a supportive school environment is crucial for developing students' literacy and numeracy skills. Similarly, Ulya et al. (2025) emphasize that adequate infrastructure, such as comfortable classrooms and innovative learning media, can directly enhance student focus and understanding of the subject matter.

Furthermore, a well-organized physical environment enriched with specific mathematical resources such as educational manipulatives, numerical visual aids, and mathematical games creates a highly stimulating cognitive atmosphere. As highlighted by Natalia (2024), a physical environment rich in such mathematical stimuli plays a crucial role in elevating students' intrinsic interest in numeracy learning. From a student-centric perspective, consistent daily exposure to these tangible numeracy tools seamlessly facilitates a deeper, more intuitive comprehension of mathematical concepts.

However, the presence of adequate physical facilities does not always correlate directly with improved mathematical academic achievement. Rizky et al. (2024) found that differences between indoor and outdoor learning settings do not yield significant effects on final achievement scores but rather impact student motivation and engagement. This is reinforced by Efendi et al. (2023), who

assert that complete facilities will not yield optimal results without supportive environmental management from the school. These varying results suggest that the effectiveness of the physical environment depends heavily on how educators integrate it into instructional strategies. Furthermore, Fadillahsyah and Hasanuddin (2025) argue that beyond physical facilities, social interaction and the academic culture established by educators play a pivotal role in fostering sustainable learning motivation.

Socio-emotional dimension and classroom climate

The social dimension and emotional climate also play a determinant role. Saleh (2025) identifies a positive emotional climate and the teacher's role as a facilitator as key factors in encouraging active student participation. Such a positive atmosphere has been proven to significantly impact focus and motivation, contributing 32.3% to mathematics learning outcomes (Prawidia & Khusna, 2021). Furthermore, Ayyubi et al. (2025) found that the learning environment's influence on mathematics achievement is remarkably strong, contributing up to 60.4%. This high percentage proves that affective and psychological aspects within the social environment determine students' readiness for numerical problem-solving. Habsy et al. (2023) add that a positive environment must provide a safe space where students feel brave enough to process information, make mistakes, and engage in self-reflection without fear.

Compared to the physical environment, the evidence suggests that the social dimension exerts a more stable and direct influence on numeracy skills, as it relates to the affective and motivational aspects of learning readiness. Moreover, Kusumaningrum et al., (2024) emphasize that synergy within the "tri-center of education" is necessary to create a holistic learning ecosystem that addresses both cognitive aspects and character building. Additionally, Darmawan et al., (2021) highlight that teacher communication skills and exemplary behavior serve as triggers for students' intrinsic motivation.

Integrated learning approaches and ecosystems

Regarding integrated instructional approaches, Hayati and Jannah (2024) emphasize that active and interactive learning environments are required to foster critical thinking, which is the foundation of mathematical literacy. This cultivation of numeracy must be integrated into core learning activities, both individually and in groups (Rahmayanti & Sutarna, 2022). To ensure sustainability, a complete ecosystem is required; Nugroho & Dewi (2024) stress the urgency of collaboration between family, school, and community as the primary foundation for internalizing literacy and numeracy practices.

In conclusion, the analysis shows that every element of the learning environment is complementary. The physical environment provides space for exploration, the socio-emotional environment strengthens motivation and academic achievement, and interactive pedagogical approaches sharpen numerical reasoning. Consequently, enhancing mathematics outcomes and numeracy literacy cannot be achieved through physical aspects alone but requires an integrated learning ecosystem, well-managed by educators and supported by the synergy of the tri-center of education.

CONCLUSION

This narrative literature review underscores that the learning environment is not merely a passive background for instruction but a multi-dimensional catalyst that determines the trajectory of students' numeracy development. The synthesis of recent evidence confirms that a comprehensive management of learning environments integrating optimized physical infrastructure, a supportive socio-emotional climate, and strategic digital integration exerts a significant positive influence on mathematics learning outcomes. This academic achievement, in turn, functions as the cognitive prerequisite for fostering sustainable numerical reasoning. Crucially, this study establishes that numeracy cultivation is a holistic endeavor that transcends classroom boundaries, necessitating a

synergistic ecosystem driven by the collaboration of the tri-center of education: family, school, and community.

As a critical standpoint of this qualitative narrative study, it is argued that evaluating educational environments must shift from broad, generic classifications to a more rigorous exploration of 9 specific dimensions of the learning environment such as safety climate, inclusivity, gender equality, and instructional leadership. Furthermore, future academic frameworks and assessment instruments must be strictly constructed from a student-centric perception (POV). Understanding how learners actively experience and perceive their psychological and physical surroundings provides a more profound, contextually accurate methodology for educational research than traditional teacher-centric or purely managerial assessments.

Theoretical and practical implications

From a theoretical perspective, these findings provide a robust framework for understanding the interplay between affective-environmental factors and mathematical cognitive growth. Practically, this study offers a clear mandate for educators and policymakers to shift from traditional instructional designs toward the creation of adaptive and interactive learning ecosystems. Designing such environments is no longer optional but a fundamental requirement for elevating the quality of modern mathematics education.

Limitations and future research

Despite its contributions, this review highlights a noticeable geographical and academic tier imbalance in existing literature. As the majority of current studies are concentrated at the elementary education level, there is an urgent need for empirical investigations at the secondary education tier, particularly involving junior high school students. Future research should prioritize longitudinal and cross-demographic studies to evaluate the long-term effectiveness of these dimensional environmental management models in bridging the gap between formal mathematics achievement and real-world numeracy proficiency from the student's perspective.

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