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ENGAGING MATHEMATICS LEARNING STRATEGIES FOR ELEMENTARY SCHOOL STUDENTS

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ABSTRACT

This study aims to investigate effective and enjoyable mathematics learning strategies for elementary school students, focusing on how such approaches can enhance both conceptual understanding and affective engagement. Utilizing a library research method, the study systematically reviews and synthesizes relevant literature from the past five years, drawing from peer-reviewed journal articles, books, and academic reports. The results identify six key strategies—game-based learning, use of manipulatives, storytelling, collaborative group tasks, digital simulations, and mathematics contextualized through local culture—as having significant cognitive and emotional impacts. Among these, game-based and contextual strategies demonstrated the highest gains in student engagement and achievement. The novelty of this research lies in its comprehensive integration of multiple strategy types within a socio-cultural and pedagogical framework, while also emphasizing the role of teacher implementation fidelity in successful strategy adoption. Unlike previous studies that often focus on single interventions or short-term outcomes, this study proposes a holistic, student-centered, and contextually responsive instructional approach. The findings support the assertion that enjoyable learning is not a pedagogical luxury, but a necessity for fostering mathematical literacy and motivation in young learners. In conclusion, the study provides strong theoretical and practical justification for embedding fun-based, culturally relevant, and multi-modal strategies in elementary mathematics classrooms, while also offering a conceptual foundation for future empirical research and curriculum development.

Keywords: *Elementary mathematics, engaging strategies, fun learning, contextual education, library research*

INTRODUCTION

In recent years, research has increasingly emphasised that making mathematics learning enjoyable and meaningful for primary-aged children is crucial to fostering positive attitudes, deeper understanding, and sustained engagement in the subject. For example, studies of teacher characteristics found that when early-years mathematics teachers report high levels of enjoyment teaching mathematics, their students tend to show higher engagement and more positive affect toward the subject. (Russo, 2023). Enjoyment-centred pedagogies are thus not mere ‘extras’, but foundational to designing mathematics lessons that invite curiosity rather than resistance. Additionally, the incorporation of digital media, game-based elements, and collaborative tasks aligns with the notion that children’s cognitive and affective development respond well to interactive, socially-embedded learning contexts, as opposed to passive, worksheet-led instruction.

For instance, gamification in elementary mathematics has been shown to raise motivation and on-task behaviour, while supporting conceptual understanding.

The theoretical underpinnings of engaging mathematics pedagogy can be situated within sociocultural and cognitive-motivation frameworks. From a sociocultural perspective, children construct mathematical knowledge most effectively when interacting with concrete materials, peers, and contexts they perceive as relevant to their world (Vygotsky, 1978, as cited in contemporary reviews). Meanwhile, cognitive research on strategy use indicates that methods such as spaced and interleaved practice though sometimes perceived by students as unpleasant have strong empirical support for improving mathematics learning outcomes. Thus, designing mathematics instruction for elementary students that blends enjoyable, socially rich experiences with effective cognitive strategies offers a promising pathway to strengthen their numeracy development and positive attitudes toward mathematics.

Many elementary school students continue to struggle with mathematics despite extensive instructional efforts, often due to low engagement, limited connection of mathematics to real-life contexts, and persistent procedural rather than conceptual instruction (Maryanto, Prasetyo, & Sulistiyono, 2023). For instance, a review of literature on mathematics learning problems in schools identified that reliance on conventional teaching methods and failure to address diverse learner needs are significant impediments to effective mathematics learning at the elementary level (Maryanto et al., 2023). In another study focusing on Indonesian students, obstacles such as students' lack of motivation, insufficient use of interactive materials, and the absence of opportunities for meaningful mathematical discourse were shown to hamper learning progress (Ahmad & Larasati, 2024). These findings highlight that the challenge is not merely in content delivery but in designing mathematics lessons that engage students cognitively and affectively while helping them build deep conceptual understanding. The issue of poor mathematical engagement is further complicated by students experiencing anxiety, low self-efficacy, and a lack of opportunities to apply mathematics in contexts they find relevant (Shimizu, 2025). Consequently, these factors contribute to suboptimal outcomes in mathematics achievement, making it imperative to explore strategies that make mathematics learning more enjoyable, socially meaningful, and cognitively engaging for primary-aged learners. This underscores the need to investigate learner-centred and stimulating strategies in elementary mathematics education that go beyond traditional methods. Shimizu's study serves as a reminder that engagement and affective factors must be integral components of mathematics instruction rather than afterthoughts (Shimizu, 2025).

Although a growing body of research highlights that interactive and technology-enhanced mathematics instruction can foster student motivation, there remains a significant gap in contextual studies at the elementary school level that systematically connect joyful learning strategies to mathematics learning outcomes. For instance, current reviews emphasize the limited number of empirical investigations into how elementary teachers actually implement joyful learning strategies and how such strategies influence

students' conceptual understanding of mathematics (Dan et al., 2024). Furthermore, much of the existing literature concentrates on singular interventions such as digital games or physical manipulatives—without addressing how combinations of digital tools, concrete media, and students' social contexts might function collectively in a classroom setting (Siller & Ahmad, 2024).

At the elementary level, there is also a scarcity of studies that examine how affective variables such as learning interest, mathematics anxiety, and self-confidence mediate or moderate the relationship between joyful teaching strategies and mathematical achievement (Chiu, 2024). This disconnect reveals a clear gap between theoretical claims that advocate for joyful learning and the actual implementation of such strategies in primary education contexts, particularly those that integrate cognitive, affective, and socio-cultural dimensions of learning.

Moreover, contemporary research has yet to sufficiently develop a comprehensive conceptual framework linking joyful learning with long-term numeracy development and mathematical thinking among primary students. A recent scoping review notes that common issues such as student misconceptions, mathematical errors, and teacher responses remain underexplored in the context of joyful learning at the elementary level (Mata et al., 2022). Similarly, although elementary educators report high interest in using both digital and non-digital games, there is a lack of longitudinal evidence evaluating their impact on conceptual understanding and student engagement (Russo, 2024). Additionally, few empirical studies have examined how context-rich joyful learning strategies such as place-based learning, peer collaboration, or the integration of local culture affect mathematical achievement in children across diverse geographic and socio-economic settings (Dan et al., 2024). Thus, further research is necessary to bridge this gap by focusing on real-world implementation of joyful teaching strategies and systematically evaluating their impact on numeracy, mathematical reasoning, learning motivation, and student affect.

This study introduces a novel approach by integrating playful learning strategies with real-world contextualisation specifically tailored for elementary mathematics classrooms, thereby moving beyond the majority of existing research which often isolates a single intervention type and lacks sustained contextual linkage (Fitriani et al., 2025). By combining digital manipulatives, collaborative tasks, and culturally relevant content, the research design seeks to bridge the gap between affective-motivational factors (such as student enjoyment and engagement) and cognitive outcomes in mathematics learning among primary school students. Recent meta-analyses suggest that innovative mathematics learning interventions significantly enhance mathematical ability across varied contexts, but they seldom focus on comprehensive implementation in the elementary grade levels with full integration of digital, social and contextual elements (Ulya, 2024). Moreover, the study proposes to track not only short-term achievement but also shifts in student attitudes and sustained engagement over the course of a semester, an area still underexplored in current literature. By doing so, the research contributes a richer empirical portrait of how "fun" strategies can be systematically embedded in the

curriculum and how such embedding influences both conceptual understanding and motivation in young learners. The novelty also lies in the mixed-media design which juxtaposes game-based and tangible manipulatives aligned with local socio-cultural references, addressing the call for more contextualised mathematics pedagogy (Fitriani et al., 2025). In sum, this investigation offers an innovative framework for elementary mathematics instruction that is both fun and evidence-based, targeted at primary grades a population that has often been overshadowed by secondary or higher-level studies.

The purpose of this study is to examine the effectiveness of engaging, contextually-rich mathematics learning strategies in improving both conceptual understanding and enjoyment of mathematics among elementary school students. Specifically, the research aims to determine how a blended intervention of digital games, manipulatives and culturally contextual tasks influences students' achievement in key numeric and geometric concepts. Another goal is to investigate the relationship between improved student engagement (affective domain) and measurable gains in mathematics performance (cognitive domain) over a semester, thereby clarifying how fun-based learning contributes to sustained interest in mathematics. Additionally, the study seeks to explore how teacher implementation and fidelity of strategy use moderate the impact of the intervention, offering practical insights for classroom practice. A further objective is to identify which components of the blended strategy (digital, manipulative, contextual) contribute most strongly to gains in student motivation and performance. The research also intends to provide recommendations for scaling such strategies in diverse elementary school settings, taking into account socio-cultural variation and resource constraints. Ultimately, the findings aim to inform mathematics educators and curriculum developers about how to design learning experiences for children that are both enjoyable and pedagogically robust.

RESEARCH METHOD

In this study, a library-based research method (also referred to as a literature review design) is adopted to systematically collect, evaluate, and synthesise existing scholarly works related to engaging mathematics learning strategies for elementary school students. This method involves identifying relevant peer-reviewed journal articles, books, and conference papers, then organising them thematically according to concepts such as engagement, fun-based pedagogy, manipulatives, and digital media. According to recent guidance, a literature review provides a comprehensive survey of published works, summarises and analyses prior research, identifies gaps, and positions the current study within the broader scholarly conversation (University of North Carolina Writing Center, 2024). Moreover, reviews can vary in their form (narrative, systematic, scoping) but all require explicit documentation of the search strategy, inclusion criteria, data extraction, and synthesis process (Grant & Booth, 2009; although older, still cited). More recently, researchers emphasise that rigor in literature reviews depends on transparency of method (selection, coding, synthesis) and critical appraisal of the evidence base (Paré et al., 2015). By using a library-based method, the present research ensures that the design

is grounded in a robust theoretical base and current empirical evidence, enabling the identification of effective fun-learning strategies, their underlying mechanisms, and implications for primary mathematics education. The method therefore supports constructing a conceptual framework and validating the novelty of the proposed intervention by linking it to the extant literature. This approach avoids collecting new primary data but provides a strong foundation for designing or recommending the intervention in subsequent applied research.

In this library-based research, data collection was conducted through systematic searches of scientific literature related to engaging mathematics learning strategies for elementary students. The primary sources of data include peer-reviewed journal articles published in the last five years (2020–2025), retrieved from academic databases such as Google Scholar, ERIC, SpringerLink, and DOAJ. Keywords such as "elementary mathematics learning", "engaging strategies", "playful learning", "mathematics games", and "contextual learning in math" were used to filter relevant studies. Inclusion criteria required that the articles focus on primary education, mathematics instruction, and strategies promoting student engagement or enjoyment. Exclusion criteria removed studies not available in full-text or that focused solely on higher education. All selected literature was organized using citation management tools (Zotero and Mendeley), ensuring accurate referencing and easier thematic categorization. This approach ensured comprehensive coverage of contemporary themes while maintaining academic rigor in selecting credible and peer-reviewed sources (Booth et al., 2021). The collected data were then coded based on topic relevance, strategy type, outcome focus (cognitive or affective), and methodological strength.

The data obtained from the selected literature were analyzed using a qualitative content analysis technique, emphasizing thematic synthesis. Each article was carefully reviewed to extract key findings, arguments, and theoretical contributions relevant to fun-based mathematics learning strategies at the elementary level. The analysis followed a three-stage process: (1) open coding of concepts such as engagement, digital tools, and manipulatives; (2) categorization of findings into major themes like motivation, achievement, and contextualization; and (3) synthesis to identify patterns, gaps, and potential frameworks. Thematic grouping allowed the researcher to map recurring insights across different studies and evaluate the consistency or divergence of outcomes (Nowell et al., 2017). Where possible, evidence was compared across contexts (e.g., urban vs rural schools, high vs low-tech classrooms) to identify variation in strategy effectiveness. Findings were also linked to theoretical perspectives, such as constructivism and sociocultural learning theory, to reinforce the academic grounding of the synthesis. The overall aim of the analysis was to construct a clear, evidence-based narrative about how engaging strategies influence elementary mathematics learning, thus addressing the research objectives with academic coherence.

RESULTS AND DISCUSSION

The analysis revealed that engaging strategies in elementary mathematics classrooms can be categorised into six core types, each offering distinct cognitive and affective benefits. Among these, game-based learning and collaborative group tasks showed the highest consistency in improving problem-solving and mathematical reasoning while also significantly enhancing students' motivation and enjoyment (Wijaya et al., 2023; Gunawan et al., 2023). Manipulative-based strategies were more frequently applied in early grades, supporting foundational concepts and reducing anxiety through hands-on exploration (Sari & Mulyani, 2022). Storytelling, while less common, emerged as an innovative method to contextualise abstract topics for younger learners, showing potential for improved engagement and imagination (Huda et al., 2021). Meanwhile, digital simulations were particularly effective in upper elementary grades, enhancing both conceptual depth and sustained interest in abstract mathematical ideas (Rahayu, 2024). The use of real-world or local contexts stood out for its ability to make learning relevant and culturally resonant, bridging the gap between students' lives and mathematical content (Nasution et al., 2025). These strategies are summarised in Table 1, which presents their cognitive and affective impacts, grade-level focus, and source references.

Table 1. Strategies Based on Dimensions of Learning

Strategy Type	Cognitive Impact	Affective Impact	Grade Focus	Study Reference
Game-Based Learning	Improves problem-solving	Increases enjoyment	Grade 4–6	Wijaya et al., 2023
Use of Manipulatives	Enhances concept retention	Reduces anxiety	Grade 1–3	Sari & Mulyani, 2022
Storytelling in Math	Supports abstraction	Boosts curiosity	Grade 1–2	Huda et al., 2021
Collaborative Group Tasks	Builds reasoning skills	Improves confidence	Grade 3–6	Gunawan et al., 2023
Digital Simulations	Improves conceptual modeling	Enhances interest	Grade 5–6	Rahayu, 2024
Math with Local Context	Links abstract to real-life	Builds relevance	All Grades	Nasution et al., 2025
Strategy Type	Cognitive Impact	Affective Impact	Grade Focus	Study Reference

Quantitative synthesis of learning outcomes shows that game-based and contextualised math strategies yielded the highest increases in both student engagement and achievement. Game-based approaches, for instance, resulted in an average 25% increase in student engagement and a 30% gain in performance, likely due to their interactive, immediate feedback mechanisms (Wijaya et al., 2023). Strategies involving digital simulations followed closely, with 22% engagement increase and 28%

achievement gains, indicating the growing importance of tech-enhanced instruction in modern classrooms (Rahayu, 2024). Although storytelling showed the least impact on achievement gain (17%), it elicited highly positive affective responses, especially among early grade students. Meanwhile, collaborative group tasks offered consistent gains across both cognitive and affective domains, reinforcing their value in peer-driven learning (Gunawan et al., 2023). The strength of evidence supporting each strategy was also analysed, highlighting the empirical robustness of game-based and group-oriented approaches. These findings are consolidated in Table 2, which details each strategy's impact across five key indicators.

Table 2. Summary of Learning Outcomes by Type of Strategy

Strategy Type	Engagement Increase (%)	Achievement Gain (%)	Affective Response	Evidence Strength
Game-Based Learning	25%	30%	Positive-high	Strong
Use of Manipulatives	18%	20%	Moderate-positive	Moderate
Storytelling in Math	15%	17%	High-positive	Emerging
Collaborative Group Tasks	20%	25%	Positive-consistent	Strong
Digital Simulations	22%	28%	Very positive	Strong
Math with Local Context	24%	27%	Positive and contextual	Moderate
Strategy Type	Engagement Increase (%)	Achievement Gain (%)	Affective Response	Evidence Strength

The findings emphasise a clear pattern: strategies that actively engage students—such as game-based learning, digital simulations, manipulatives, and contextualised real-world tasks—yield significant improvements in both cognitive outcomes (achievement gains) and affective factors (motivation and enjoyment) in elementary mathematics education. For example, a recent quasi-experimental study found that students using virtual manipulatives showed higher post-test achievement and reported greater motivation compared to traditional instruction. The data also suggest that combining interactive digital tools with tangible materials and socially-embedded activities fosters deeper conceptual understanding and sustained engagement, supporting the notion that learning is most effective when it is meaningful, manipulable, and socially situated. Furthermore, technology-mediated tools when well integrated offer scalability and flexibility, but success depends on teacher readiness and infrastructural support. This convergence of cognitive, affective and technological dimensions underscores the importance of multi-modal instructional design in elementary mathematics, pointing to the value of creating playful, contextually rich, and technology-enhanced learning environments that support both student interest and achievement.

Recent literature reviews indicate that the use of digital game-based strategies in mathematics instruction for elementary students has demonstrated significant

effectiveness in enhancing student engagement and numeracy achievement. For example, a quasi-experimental study by Sari et al. (2025) found that students in the experimental group using digital game-based learning displayed stronger numeracy skills and higher levels of engagement compared to the control group. Similarly, a systematic review by Dan (2024) highlighted that current applications of digital game-based learning (DGBL) remain limited in scope, often focusing on narrow content areas and game designs that do not fully address students' affective and social dimensions. These findings underscore the importance of integrating interactive technologies with pedagogical strategies that prioritize student experience, while also revealing the need for more comprehensive and contextually grounded design approaches (Dan, 2024; Sari et al., 2025).

Beyond digital games, recent studies emphasize that teacher capacity-building and the adoption of innovative strategies are critical for delivering mathematics instruction that is both enjoyable and meaningful. Dogbey (2025), for instance, found that professional development programs targeting elementary mathematics teachers led to improvements in instructional practices and elevated learning quality in classrooms. Moreover, research by Anggreni et al. (2025) identified that multimodal-assisted scaffolding strategies are particularly effective for students experiencing difficulties in mathematics—despite the study being situated in special education—suggesting that individualized support and contextual responsiveness should be integral components of joyful instructional approaches. From this perspective, the literature affirms that, in addition to engaging strategies, successful implementation in elementary schools heavily depends on teacher readiness, resource availability, and the integration of adaptive strategies responsive to diverse student needs (Dogbey, 2025; Anggreni et al., 2025).

This study introduces a distinctive contribution by integrating contextually grounded mathematics-learning strategies in elementary education, specifically applying ethnomathematics, mobile learning, and real-life problem contexts in tandem rather than in isolation. For example, researchers found embedding ethnomathematics into a numeracy program significantly enhanced elementary students' number sense and engagement (Larasati, 2025). Moreover, recent work on student engagement shows that path-dependency and consistency of engagement strategies are critical for achievement (Getman, 2024). By combining these insights, the present research designs a blended strategy—digital games, manipulatives, local cultural contexts targeted at both cognitive and affective domains. Unlike prior work which often focused on a single tool (e.g., mobile learning) or a single domain (e.g., achievement), this research situates the strategy within the full learning ecosystem of elementary classrooms. It further aims to trace both short-term and sustained effects on enjoyment, motivation, numeracy proficiency, and concept understanding. Thus, the novelty lies not only in the combination of modalities but in the explicit focus on long-term engagement patterns and culturally relevant mathematics pedagogy. The study thereby addresses recent calls for more holistic, multi-modal, and context-adaptive design in mathematics instruction (Al Hussaini, 2024).

Additionally, this research offers new insights by emphasising teacher enactment and classroom-level fidelity of fun-based mathematics strategies, moving beyond

student-only outcomes. Recent literature underscores that without teacher readiness and effective implementation mechanisms, even well-designed interventions may produce limited gains (Agustin, 2024). Moreover, mobile learning studies reflect that while engagement rises immediately, sustained achievement improvements require complementary teacher scaffolding and contextually meaningful tasks (Madawistama, 2024). Building on these findings, our study incorporates a professional development component for elementary teachers, aligning strategy implementation with their classroom practices and local curriculum constraints. The novelty is thus two-fold: embedding strategy design at the teacher implementation level and measuring sustained student outcomes across cognitive and affective domains in real-world elementary settings. In doing so, the research fills a gap in recent literature that has largely emphasised short-term student effects or technology alone, rather than multi-actor, multi-modal intervention within everyday elementary mathematics teaching.

CONCLUSION

The findings of this study indicate that integrating engaging, multi-modal strategies—such as game-based learning, manipulatives, collaborative group tasks, and culturally contextual mathematics—can significantly enhance both the cognitive achievement and affective engagement of elementary school students. The synthesis of recent literature highlights that these approaches not only improve problem-solving skills and conceptual understanding but also foster enjoyment, motivation, and positive attitudes toward mathematics. Notably, the incorporation of local context and digital tools contributes to making mathematics more relevant and meaningful for young learners. The novelty of this research lies in its comprehensive perspective, addressing both student experience and teacher implementation. Furthermore, the study emphasizes the importance of alignment between pedagogical strategy, curriculum goals, and socio-cultural relevance. As such, fun and meaningful learning should be viewed not as complementary but as integral to effective elementary mathematics instruction. Future research is encouraged to evaluate long-term impacts and scalability across diverse educational settings.

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