

Comparative Literature Review of Concrete Learning Media, Student Learning Interest, and Mathematical Reasoning in Elementary and Madrasah Ibtidaiyah Mathematics Education

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ABSTRACT

Elementary mathematics learning requires instructional approaches that connect abstract concepts with meaningful student experiences. However, research on concrete learning media, student learning interest, and mathematical reasoning has often examined these dimensions separately, limiting an integrated understanding across elementary schools (SD) and Madrasah Ibtidaiyah (MI). This study aimed to critically synthesize the relationships among concrete learning media, student learning interest, and mathematical reasoning and to compare patterns across SD and MI contexts. A qualitative comparative and integrative literature review was conducted using 35 research articles published between 2014 and 2024. Data were collected through systematic identification, screening, and extraction of relevant studies and analyzed using thematic analysis and comparative synthesis. The findings indicate that concrete learning media support meaningful mathematical experiences by enabling students to explore, represent, compare, and connect abstract concepts with observable activities. Learning interest emerged as an engagement-related factor that supports attention, participation, and persistence, while mathematical reasoning represented a higher-order outcome associated with opportunities to explain relationships, identify patterns, and justify solutions. The integrated synthesis suggests a conceptual pathway from concrete learning experiences to engagement and sustained mathematical participation, which creates conditions for mathematical reasoning. Similarities were evident across SD and MI, although implementation varied according to instructional and contextual conditions. The study contributes an integrated conceptual framework for understanding instructional, learner, and outcome dimensions in elementary mathematics education.

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INTRODUCTION

Mathematics education at the elementary level plays an important role in developing students' conceptual understanding, problem-solving capacity, and ability to reason with mathematical ideas. However, mathematics is frequently experienced by young learners as an abstract subject because mathematical concepts are commonly presented through symbols, procedures, and verbal explanations. This condition has encouraged researchers and teachers to

consider learning experiences that connect abstract mathematical ideas with objects, representations, meaningful contexts, and students' everyday experiences. In this regard, concrete learning media and manipulatives have been increasingly discussed as instructional resources that can facilitate conceptual understanding and active participation. Evidence from elementary mathematics education indicates that concrete media can create more active learning experiences and support students' engagement in mathematical activities (Setyawan & Sarwindae, 2018). Similarly, manipulatives can provide learners with opportunities to connect physical experiences with mathematical concepts, although their effectiveness depends considerably on the pedagogical guidance provided by teachers (Horan & Carr, 2018; Quane, 2024).

The international literature further indicates that the contribution of manipulatives extends beyond immediate conceptual understanding. A systematic review found that manipulative-based interventions can support mathematics learning among children with mathematics learning difficulties, although the effects vary according to learner characteristics, intervention design, and instructional conditions (Lafay et al., 2019). In elementary geometry, manipulatives combined with structured questioning have also been associated with improved conceptual understanding, suggesting that concrete materials become more meaningful when accompanied by instructional prompts that encourage students to explain and construct mathematical ideas (Hidayah et al., 2018). More recent research has similarly examined the relationship between concrete and virtual manipulatives, indicating that blended manipulative instruction can contribute to elementary students' mathematics achievement (Siller & Ahmad, 2024). Virtual manipulatives have also been found to provide opportunities for students to develop mathematical argumentation through interactive representations (Vallejo-Vargas & Reid, 2024). These findings suggest that learning media should not be viewed merely as physical tools but as components of pedagogical environments that shape how students interact with mathematical concepts.

Alongside instructional media, student learning interest represents an important affective dimension of mathematics education. International evidence indicates reciprocal relationships among mathematics interest, self-efficacy, anxiety, and achievement, demonstrating that students' affective experiences cannot be separated completely from their mathematical development (Du et al., 2021). In Indonesia, research has similarly reported relationships between students' learning interest and mathematics achievement at the elementary level (Rofiqoh et al., 2020). Realistic mathematics approaches have been reported to support students' interest by presenting mathematical situations that are closer to learners' experiences (Herzamzam, 2018), while learning environments are also associated with students' interest and mathematics learning outcomes (Pratiwi et al., 2018). Other studies indicate that instructional media can strengthen interest when students are actively engaged with learning materials (Ernawati et al., 2020), whereas changes in the learning environment can influence students' experiences and interest in mathematics (Oktavia et al., 2020). Cooperative learning has likewise been identified as an instructional approach that can support students' involvement and interest through individual and group participation (Sarinem & Hidayati, 2019).

Learning interest is particularly relevant when mathematics education is considered in relation to mathematical reasoning. Reasoning requires students not only to obtain correct answers but also to identify relationships, interpret information, justify procedures, and construct explanations. Indonesian research has demonstrated the potential of Predict-Observe-Explain learning to improve mathematical reasoning among elementary students (Nuraeni et al., 2019). Other studies have examined reasoning through PISA-type mathematical problems and higher-order thinking activities, emphasizing the importance of students' abilities to formulate, apply,

interpret, and evaluate mathematical information (Linda & Asyura, 2021; Sholikhah & Chamidah, 2022). Numerical reasoning also requires students to employ cognitive processes when understanding and solving mathematical problems (Meirisa et al., 2021). Furthermore, learning interest has been associated with how students approach mathematical reasoning tasks (Yuliani, 2021), while affective factors such as self-efficacy and mathematical disposition have also been related to elementary students' mathematical reasoning (Gulo et al., 2024; Regita & Wahyudin, 2024). Thus, mathematical reasoning should be understood within an instructional and affective environment rather than as an isolated cognitive outcome.

The Indonesian context provides further evidence regarding the potential contribution of concrete and contextual learning. Realistic mathematics education supported by concrete media can facilitate students' mathematical representation by connecting mathematical concepts with observable objects and experiences (Kusumaningrum & Nuriadin, 2022). Problem-based numerical literacy activities can also provide opportunities for elementary students to apply mathematical concepts while developing reasoning abilities (Nurbaya et al., 2022). Similarly, worksheets based on Creative Problem Solving can encourage students to engage in problem-solving activities that support mathematical reasoning (Jusmawati et al., 2021). The design of mathematical tasks is also important because task characteristics and cognitive demands are associated with elementary students' mathematical problem-solving performance (Vessonen et al., 2024). These findings collectively indicate that mathematical reasoning develops through an interaction among instructional design, learning resources, cognitive demands, and students' affective engagement.

Several studies provide particularly relevant evidence concerning concrete learning and mathematical reasoning. Saleh et al. (2018) found that Indonesian Realistic Mathematics Education could improve elementary students' mathematical reasoning compared with conventional instruction, while emphasizing the role of concrete experiences as a bridge toward abstract mathematical concepts. In another context, Horan and Carr (2018) demonstrated that the effectiveness of manipulatives depends on the amount and timing of teacher guidance. Concrete learning has also been implemented in Indonesian elementary classrooms through various forms of media. In Lombok Timur, concrete media have been associated with more active mathematics learning and improved learning outcomes (Hayati, 2019), while Montessori-based manipulatives have been developed to support students' understanding of addition (Harmayanti et al., 2022). Similar efforts have produced concrete media such as SIPITUNG for learning addition and subtraction (Wahyuni et al., 2022). Local cultural contexts can also connect students' everyday experiences with mathematics and potentially support learning interest (Hartati, 2022). In Madrasah Ibtidaiyah, teachers have used fingers, seeds, toys, and other concrete objects within realistic mathematics education, although differences in students' initial abilities and literacy and numeracy interest remain challenges (Lestari et al., 2024). Mathematical thinking in Madrasah Ibtidaiyah has also been developed through Matematika Nalaria Realistik, demonstrating the relevance of realistic and reasoning-oriented approaches in Islamic elementary education (Al-Bidayah, 2020).

Although these studies have established important findings, the existing literature remains fragmented. Previous research has largely examined concrete learning media, student learning interest, or mathematical reasoning as separate issues, while studies that connect these three dimensions within one analytical framework remain limited. Research on concrete media has predominantly focused on achievement, conceptual understanding, or representation (Hidayah et al., 2018; Harmayanti et al., 2022; Kusumaningrum & Nuriadin, 2022), whereas studies of learning interest have commonly examined its relationship with achievement, learning environments, or

instructional models (Pratiwi et al., 2018; Rofiqoh et al., 2020; Prastitasari et al., 2022). Similarly, research on mathematical reasoning has frequently emphasized problem solving, higher-order thinking, literacy, or affective factors without systematically examining how concrete learning experiences and learning interest intersect with reasoning development (Linda & Asyura, 2021; Nuraeni et al., 2019; Smit et al., 2023). Consequently, although previous studies have examined concrete media, learning interest, and mathematical reasoning, they have largely focused on individual relationships or isolated instructional outcomes, leaving the integrated relationship among these dimensions insufficiently understood, particularly across Elementary Schools and Madrasah Ibtidaiyah.

This limitation is important because Elementary Schools and Madrasah Ibtidaiyah share foundational educational goals but operate within somewhat different institutional and curricular environments. Existing local studies have demonstrated the use of concrete objects and realistic approaches in both settings, yet comparative synthesis across the two contexts remains underdeveloped. Moreover, systematic reviews have examined specific aspects of manipulatives or mathematical problem solving (Lafay et al., 2019; Vessonen et al., 2024), but they have not specifically synthesized the interaction among concrete learning media, student learning interest, and mathematical reasoning while comparing Elementary School and Madrasah Ibtidaiyah contexts.

The present study therefore offers an integrative and comparative literature-review perspective. Its novelty lies not in examining a new learning medium or a single instructional intervention, but in bringing together three dimensions that have predominantly been investigated separately: concrete learning media as an instructional resource, student learning interest as an affective dimension, and mathematical reasoning as a cognitive dimension. The study also extends the literature by explicitly comparing patterns across Elementary Schools and Madrasah Ibtidaiyah, including evidence from the Indonesian and local Lombok contexts. This integrative perspective enables the literature to be interpreted not simply in terms of whether concrete media improve mathematics outcomes, but in terms of how concrete learning experiences may interact with students' interest and opportunities for mathematical reasoning. Accordingly, this study aims to synthesize how previous literature describes the use of concrete learning media, how student learning interest relates to mathematics learning and mathematical reasoning, and what similarities, differences, and patterns emerge among concrete learning media, student learning interest, and mathematical reasoning in Elementary School and Madrasah Ibtidaiyah mathematics education.

METHODS

1. Research Approach and Design

This study employed a qualitative literature review approach to examine and synthesize previous research on concrete learning media, student learning interest, and mathematical reasoning in mathematics education at Elementary Schools (SD) and Madrasah Ibtidaiyah (MI). A literature review was selected because the study focused on identifying patterns, similarities, differences, and relationships across previously published studies rather than collecting primary data from students or teachers. The review was designed as a comparative and integrative literature review, allowing findings from different studies to be organized according to the three main dimensions and compared across SD and MI contexts. A literature review was considered appropriate when previous evidence needed to be systematically examined and connected to develop a broader understanding of a research problem (Hart, 2018). Similarly, the literature-review process required a clearly defined research focus, purposeful selection of relevant literature,

and organized synthesis rather than a simple description of individual studies (Machi & McEvoy, 2016).

The review was guided by three research questions concerning the use of concrete learning media, the relationship between student learning interest and mathematics learning and reasoning, and the similarities, differences, and patterns among the three dimensions in SD and MI mathematics education. The design therefore emphasized thematic comparison and synthesis. The analysis did not attempt to statistically combine effect sizes because the selected studies differed in research designs, participants, interventions, instruments, and reported outcomes. This approach was also consistent with the principle that qualitative research methods were appropriate when researchers sought to understand and interpret complex patterns within educational phenomena (Creswell & Poth, 2018).

2. Literature Sample and Selection Criteria

The literature sample consisted of 35 research articles published between 2014 and 2024. The articles were selected because they directly or indirectly addressed at least one of the study's three central dimensions: concrete learning media, student learning interest, or mathematical reasoning in mathematics education. Studies involving elementary-level learners were prioritized, while studies conducted in closely related educational contexts were considered when their findings contributed directly to understanding one of the three dimensions. The sample also included studies representing both general elementary education and Islamic elementary education, particularly Madrasah Ibtidaiyah, to support the comparative purpose of the study.

The selection process followed predetermined inclusion criteria. Articles were included when they (1) were published within the 2014–2024 period, (2) discussed mathematics education or mathematics learning, (3) addressed concrete or manipulative learning media, learning interest, mathematical reasoning, or a combination of these variables, and (4) provided sufficient findings for thematic interpretation and comparison. Studies that were unrelated to elementary mathematics education, did not provide relevant findings, or fell outside the specified publication period were excluded. This procedure was intended to maintain a focused and manageable literature sample while retaining studies that were substantively relevant to the research questions. The use of explicit criteria was important because a literature review required researchers to establish boundaries for the literature being examined and to make the selection process transparent (Aveyard, 2019).

The final sample of 35 articles was treated as the unit of analysis. Each article was not merely counted as a separate source but was examined for its research context, participants, methodological characteristics, principal findings, and relevance to the three dimensions of the present study. Such organization helped prevent the review from becoming a collection of disconnected summaries and enabled the findings to be synthesized across studies.

3. Data Sources and Data Collection Procedure

The data sources consisted entirely of secondary data obtained from the 35 selected research articles. The literature was identified through academic databases, journal platforms, and accessible scholarly sources using combinations of keywords related to *concrete learning media*, *concrete manipulatives*, *mathematics learning*, *student learning interest*, *mathematical reasoning*, *elementary school*, *Madrasah Ibtidaiyah*, and related Indonesian terminology. The search was conducted within the 2014–2024 publication period.

The data collection procedure was conducted in several connected stages. First, potentially relevant articles were identified through keyword-based searches. Second, titles and abstracts were examined to determine their initial relevance to the research questions. Third, potentially relevant

articles were read in greater detail, and those meeting the inclusion criteria were retained. Fourth, information from the selected studies was recorded in a literature extraction matrix. The matrix included the author and year, research context, educational level, research focus, participants, methodology, learning media or variables examined, and major findings. This procedure provided an organized basis for comparing the 35 studies. In literature research, a structured process of identifying, organizing, and reviewing relevant evidence is necessary to ensure that the synthesis is based on identifiable and relevant sources (Booth et al., 2021).

The extraction process was also designed to distinguish findings related to concrete learning media, student learning interest, and mathematical reasoning. Where a study addressed more than one dimension, its findings were recorded under the relevant categories rather than being assigned exclusively to a single category. This enabled the review to identify connections among the three dimensions and supported the comparative analysis between SD and MI contexts.

4. Data Analysis Technique

The collected literature was analyzed using thematic analysis and comparative synthesis. The analysis was conducted through four main stages. First, the researchers read the selected articles repeatedly to identify meaningful findings related to the research questions. Second, relevant findings were coded according to the three principal dimensions: concrete learning media, student learning interest, and mathematical reasoning. Third, related codes were grouped into broader themes and subthemes. Fourth, the themes were compared across SD and MI contexts to identify recurring patterns, similarities, differences, and areas that remained insufficiently examined.

The analysis focused on the substance of findings rather than simply reproducing the conclusions of individual studies. For example, studies reporting the use of manipulatives or concrete materials were compared according to their instructional purpose and reported learning outcomes. Studies addressing learning interest were examined for their relationship with mathematics learning, engagement, achievement, or reasoning. Studies on mathematical reasoning were analyzed in relation to instructional approaches, learning conditions, and learner characteristics. This thematic organization enabled the review to move from individual findings toward an integrated interpretation.

The analytical process also followed the principle that qualitative data should be organized systematically before interpretation. Indonesian methodological literature emphasizes that qualitative analysis involves organizing data, identifying relevant categories, interpreting patterns, and drawing conclusions from meaningful relationships within the data (Emzir, 2018). Similarly, qualitative methodological procedures require researchers to organize evidence carefully so that interpretations remain grounded in the data rather than being based on unsupported assumptions (Herdiansyah, 2019).

5. Comparative and Integrative Synthesis

After thematic coding, the findings were synthesized comparatively between Elementary Schools and Madrasah Ibtidaiyah. The comparison was conducted according to the three research dimensions and was intended to identify how each dimension had been represented in previous literature. Particular attention was given to whether concrete learning media were associated with students' engagement and understanding, whether learning interest was related to mathematics learning and reasoning, and whether mathematical reasoning was developed through particular instructional approaches or learning conditions.

The synthesis then integrated the three dimensions to identify broader patterns. Rather than assuming that concrete media, learning interest, and mathematical reasoning operated independently, the review examined how previous studies suggested possible connections among

them. The synthesis therefore considered concrete media as an instructional factor, learning interest as a learner-related factor, and mathematical reasoning as an important mathematics-learning outcome. This integrative procedure was intended to produce a more comprehensive understanding than would be obtained by reviewing each variable separately.

The comparative interpretation also considered the characteristics of SD and MI as educational contexts. Findings were not treated as automatically equivalent across the two settings; instead, differences in educational context, instructional practice, and research emphasis were considered when interpreting patterns. This approach was consistent with the view that educational research should consider the relationship between research findings and the contexts in which those findings were produced (Sukmadinata, 2017).

6. Trustworthiness and Research Quality

The trustworthiness of the review was maintained through source relevance, consistency of selection criteria, systematic data extraction, and cross-study comparison. The researchers used the same principal criteria when examining the 35 articles and organized information using a consistent extraction framework. Findings were compared across multiple studies rather than being interpreted from a single source. Where studies produced different findings, the differences were retained and considered as part of the synthesis rather than being eliminated.

The review also maintained a clear distinction between findings reported by the original studies and interpretations developed through the present synthesis. This procedure was important for reducing unsupported generalization and ensuring that conclusions remained connected to the available literature. In qualitative research, methodological rigor depends on a transparent research process, careful handling of data, and consistency between the research questions, data sources, analysis, and interpretation (Moleong, 2017). Accordingly, the present review treated methodological transparency as an essential part of the research process.

7. Ethical Considerations

Because the study used published literature and did not involve direct interaction with human participants, no primary participant recruitment or intervention was conducted. Nevertheless, academic and ethical standards were maintained by accurately representing the findings of the reviewed studies, avoiding misinterpretation, and providing appropriate citations for all sources used. The researchers also retained the original context of the findings when comparing studies across SD and MI settings. The methodological process emphasized responsible use of published evidence and avoided presenting interpretations as empirical findings of the original studies. This principle supported the academic integrity of the review and strengthened the reliability of the resulting synthesis (Sugiyono, 2019).

RESULTS

1. Concrete Learning Media in Mathematics Education at SD and MI

The analysis of the 35 studies published between 2014 and 2024 indicated that concrete learning media had been consistently used as an instructional bridge between students' direct experiences and abstract mathematical concepts. Across the reviewed literature, concrete media were not limited to physical teaching aids but were generally incorporated into activities in which students could observe, manipulate, classify, compare, count, measure, or represent mathematical ideas. The literature therefore showed a recurring shift from teacher explanation toward more experiential forms of mathematics learning. This pattern was evident in studies of manipulatives, concrete objects, Montessori-based materials, contextual objects, and realistic mathematics education, although the specific media and instructional procedures varied across studies.

a. Patterns of Concrete Learning Media Use

1) Types and Forms of Concrete Learning Media

The reviewed studies revealed considerable diversity in the forms of concrete learning media used in elementary mathematics. At the basic level, teachers and researchers employed ordinary concrete objects and easily accessible materials to represent numerical and arithmetic concepts. Setyawan and Sarwindae (2018), for example, examined concrete media combined with the *talking stick* model in Grade 1 mathematics, while Hayati (2019) reported the use of concrete media in Grade 4 mathematics learning. Similar patterns appeared in studies using sticks, counting materials, Montessori-based objects, and other manipulatives to represent addition, subtraction, number relationships, and place value.

A second category consisted of structured mathematical manipulatives designed for particular mathematical concepts. Hidayah et al. (2018) examined manipulatives for solid geometry, while Horan and Carr (2018) investigated manipulatives in early mathematics learning. Lafay et al. (2019), through a systematic review, further demonstrated that manipulatives had been used in interventions designed to support mathematics learning among children experiencing mathematics learning difficulties. These findings suggested that concrete media were most frequently selected when students needed support in translating abstract mathematical relationships into observable or manipulable representations.

The literature also showed the development of contextual and culturally familiar materials. Hartati (2022) discussed ethnomathematics as a contextual basis for elementary mathematics learning, while Harmayanti et al. (2022) developed a Montessori-based addition tube for elementary students in Lombok. Wahyuni et al. (2022) similarly developed SIPITUNG as a concrete-oriented counting medium. These studies indicated that concrete learning media could be constructed from materials that were familiar to students and adapted to local learning environments.

2) Learning Functions and Instructional Purposes

Across the 35 studies, concrete learning media primarily functioned as representational, explanatory, exploratory, and engagement-supporting tools. Their central instructional purpose was to make mathematical concepts more observable and accessible before students moved toward symbolic procedures. In studies concerning arithmetic, concrete objects allowed students to physically model quantities and operations; in geometry, manipulatives supported the visualization and construction of spatial relationships. Hidayah et al. (2018) showed the relevance of manipulatives and structured questioning in solid-geometry instruction, while Kusumaningrum and Nuriadin (2022) reported the contribution of concrete media within realistic mathematics education to students' mathematical representation.

The literature also indicated that concrete media were frequently integrated with particular learning models rather than used as isolated teaching aids. Setyawan and Sarwindae (2018) combined concrete media with the *talking stick* model, while Kusumaningrum and Nuriadin (2022) integrated concrete media with realistic mathematics education. Jusmawati et al. (2021) and Nuraeni et al. (2019) further demonstrated that mathematics learning outcomes and reasoning could be supported through structured instructional approaches involving active student participation. Thus, the effectiveness of concrete media appeared to depend not only on the physical material itself but also on how teachers incorporated it into learning activities.

In the MI context, this instructional function was particularly visible in studies using contextual and realistic approaches. The literature showed that concrete materials were frequently connected with real-life situations so that students could move from familiar experiences toward mathematical representations. Recent MI research similarly reported that concrete-object learning

could address difficulties arising when mathematical concepts were presented predominantly in abstract form.

3) Contributions to Students' Mathematical Understanding

The reviewed literature generally indicated that concrete learning media contributed to conceptual understanding, representation, procedural comprehension, and learning engagement. In arithmetic learning, students were better supported in understanding quantities and operations when mathematical symbols were connected to physical objects. In geometry and measurement, manipulatives provided opportunities for students to visualize relationships that were difficult to understand through verbal explanation alone.

This pattern was consistent with the findings of Hidayah et al. (2018), Lafay et al. (2019), Kusumaningrum and Nuriadin (2022), and Siller and Ahmad (2024), although the studies differed in their instructional contexts and research designs. Siller and Ahmad (2024), in particular, showed that concrete and virtual manipulative instruction could be combined to support elementary students' mathematics achievement. Vallejo-Vargas and Reid (2024) also extended the discussion by demonstrating that manipulative environments could support mathematical argumentation, suggesting that manipulatives were not restricted to basic calculation but could also contribute to more complex mathematical thinking.

The Indonesian literature reflected a similar tendency. Hayati (2019), Setyawan and Sarwindae (2018), Harmayanti et al. (2022), Wahyuni et al. (2022), and Kusumaningrum and Nuriadin (2022) collectively indicated that concrete or manipulative learning environments could facilitate students' understanding of mathematical concepts and improve their participation in learning activities. Therefore, the synthesis suggested that the primary contribution of concrete media was not simply improving test scores but providing a transitional learning environment in which students could construct mathematical meaning through direct interaction with objects and representations.

b. Comparative Patterns Between SD and MI

1) Similarities in the Use of Concrete Media

The comparison showed substantial similarities between SD and MI in the pedagogical use of concrete learning media. In both contexts, concrete materials were predominantly employed to address the difficulty of understanding abstract mathematical concepts. The reviewed studies from both settings emphasized students' active involvement, visualization, manipulation, and connection between mathematical concepts and observable situations.

The similarity was also evident in the types of learning outcomes emphasized. Studies from SD and MI commonly associated concrete media with improved conceptual understanding, mathematics achievement, student activity, and engagement. The use of concrete materials was therefore not unique to either educational setting; rather, it represented a broader instructional strategy in elementary mathematics education.

2) Differences in Instructional Implementation

Despite these similarities, the literature revealed differences in instructional emphasis and contextual integration. Studies conducted in SD tended to examine concrete media within specific mathematics topics, such as geometry, arithmetic, measurement, representation, and general mathematics achievement. Several studies also combined manipulatives with broader instructional models, including realistic mathematics education, problem-based learning, or structured classroom activities.

In MI, concrete media were more frequently discussed alongside contextual, realistic, Montessori-based, or locally relevant mathematics instruction. Harmayanti et al. (2022), for

instance, focused on a Montessori-based concrete medium in Lombok, while Al-Bidayah (2020) examined realistic mathematics-oriented mathematical thinking in Madrasah Ibtidaiyah. This pattern suggested that MI studies tended to place concrete media within a broader effort to connect mathematics learning with students' contextual and educational environments.

The distinction should not be interpreted as an absolute difference between SD and MI because the reviewed studies did not employ identical research designs or measures. Rather, it represented a difference in research emphasis across the available literature.

3) Contextual Factors Influencing Media Use

The synthesis further indicated that the use of concrete learning media was influenced by curriculum, teacher practice, material availability, student characteristics, learning objectives, and local context. In both SD and MI, teachers needed to select materials that corresponded with students' developmental levels and the mathematical concepts being taught. Concrete media were particularly relevant when students encountered concepts that were difficult to visualize through symbolic instruction alone.

In MI, contextual factors also included the integration of mathematics with the broader characteristics of madrasah education and locally meaningful learning practices. Research from Lombok and other Indonesian settings illustrated how simple, accessible, and culturally familiar materials could be transformed into mathematics-learning resources. This contextual orientation was consistent with the broader evidence that concrete media were more meaningful when they were connected to students' experiences rather than presented merely as physical objects.

Overall, the analysis of the 35 studies indicated that concrete learning media functioned most effectively when they were pedagogically integrated with meaningful mathematical activities. The evidence across SD and MI converged on the importance of moving students from concrete experiences toward mathematical representation and abstraction. At the same time, the literature differed in the degree to which concrete media were connected with realistic, contextual, Montessori, problem-based, or other instructional approaches. Thus, the principal finding from this dimension was that concrete media should be understood not simply as physical teaching aids, but as instructional mediators that support students' transition from direct experience to mathematical understanding. This interpretation is also consistent with recent evidence that concrete media can support active participation and conceptual understanding when embedded in appropriately structured mathematics instruction.

2. Student Learning Interest and Mathematical Reasoning

The synthesis of the 35 studies published between 2014 and 2024 showed that student learning interest was consistently associated with students' participation in mathematics learning, their learning experiences, and, in several studies, their mathematical performance and reasoning. The literature did not treat interest as an isolated psychological characteristic. Rather, it was frequently discussed in relation to instructional approaches, classroom environments, students' self-beliefs, learning activities, and opportunities to engage meaningfully with mathematics. The findings therefore indicated that learning interest represented an important learner-related dimension within elementary mathematics education, although the strength and nature of its relationship with mathematical outcomes varied across studies.

a. Student Learning Interest in Mathematics

1) Factors Associated with Learning Interest

The reviewed literature identified several factors associated with students' interest in mathematics. One recurring factor was the quality and nature of classroom learning activities. Students tended to demonstrate greater interest when mathematics learning involved active

participation, contextual problems, interaction, and opportunities to construct understanding rather than relying exclusively on teacher explanation. Herzamzam (2018), for example, reported that realistic mathematics education could be used to increase elementary students' interest in mathematics. Similarly, Pratiwi et al. (2018) found a relationship among the learning environment, students' learning interest, and mathematics learning outcomes.

The literature also indicated that instructional media and learning models could influence students' learning experiences and consequently their interest. Studies involving concrete media, realistic mathematics education, cooperative learning, and technology-supported learning showed that instructional conditions could create different levels of student engagement. Ernawati et al. (2020) examined elementary students' mathematics interest through technology-assisted learning, while Sarinem and Hidayati (2019) reported efforts to increase mathematics learning interest through the Team Assisted Individualization model. These findings complemented studies focusing on concrete and contextual learning, suggesting that students' interest could be strengthened when mathematical activities were made more accessible and participatory.

Another important factor was the students' individual learning characteristics. Du et al. (2021), using data from 2,789 primary school students, demonstrated reciprocal relationships among mathematics interest, anxiety, self-efficacy, and achievement. This finding suggested that interest could not be separated from students' affective and motivational experiences. Wong and Wong (2019) likewise examined the relationship between interest and mathematics performance in a technology-enhanced learning context, indicating that students' interest remained relevant even when mathematics learning was mediated by technology.

The Indonesian literature also showed that learning interest could vary according to learning conditions and student characteristics. Oktavia et al. (2020) examined mathematics learning interest in online learning among lower-grade elementary students, while Prastitasari et al. (2022) examined mathematics interest during the COVID-19 pandemic from a gender perspective. Taken together, these studies indicated that learning interest was shaped by an interaction between instructional conditions and learner characteristics rather than by a single factor.

2) Learning Interest and Mathematics Learning Outcomes

Across the reviewed literature, learning interest was generally associated with more positive mathematics learning experiences and outcomes. Students who demonstrated greater interest tended to show stronger participation and engagement in mathematics activities, while learning environments that stimulated interest were more likely to support learning achievement.

Rofiqoh et al. (2020), for example, directly examined the relationship between learning interest and mathematics learning outcomes among Grade 5 elementary students and reported a relationship between the two variables. Pratiwi et al. (2018) similarly identified a relationship involving the learning environment, learning interest, and mathematics achievement. These findings were consistent with Herzamzam (2018), whose intervention-oriented study indicated that realistic mathematics education could increase students' mathematics learning interest.

International evidence provided a broader perspective. Du et al. (2021) showed that mathematics interest and achievement could influence one another over time rather than operating only in one direction. Wong and Wong (2019) also connected interest with mathematics performance in a technology-enhanced learning environment. Therefore, the literature suggested that interest should not be interpreted merely as a prerequisite for achievement. Instead, interest and successful learning experiences could potentially reinforce one another, although the reviewed studies differed in their designs and therefore did not establish a single causal pathway.

This pattern was particularly important for the present review because mathematical achievement and mathematical reasoning were not identical outcomes. Several studies demonstrated that instructional approaches associated with greater engagement could also support reasoning, representation, and higher-order mathematical thinking. Consequently, learning interest appeared to constitute an important learner-related condition through which students could become more actively involved in cognitively demanding mathematical tasks.

3) Learning Interest, Engagement, and Persistence

The 35-study synthesis further showed that learning interest was closely related to student engagement and sustained participation. Interest could encourage students to pay attention to mathematical tasks, participate in classroom activities, attempt challenging problems, and remain involved when solutions were not immediately apparent.

This relationship was particularly visible in studies examining active and contextual mathematics learning. Herzamzam (2018) showed the potential of realistic mathematics education to increase interest, while Sarinem and Hidayati (2019) emphasized cooperative learning as an approach for improving students' interest. Concrete learning studies also indirectly supported this pattern because manipulatives and contextual materials created opportunities for students to interact directly with mathematical concepts rather than passively receive information.

The longitudinal evidence reported by Du et al. (2021) strengthened this interpretation by showing that interest interacted dynamically with mathematics anxiety, self-efficacy, and achievement. Thus, persistence in mathematics learning appeared to be connected not only with whether students initially liked mathematics but also with whether the learning environment supported confidence and successful engagement.

At the same time, the literature indicated that interest could not be assumed to remain stable. Changes in learning environments, instructional modes, and students' experiences could influence it. The studies conducted during or following the COVID-19 period, including Prastitasari et al. (2022) and Oktavia et al. (2020), illustrated how changes in learning conditions could become relevant to students' mathematics interest. The overall pattern therefore positioned learning interest as a dynamic component of mathematical learning, closely connected with engagement and students' willingness to sustain effort.

b. Relationship Between Learning Interest and Mathematical Reasoning

1) Interest as a Learner-Related Factor

The literature indicated that mathematical reasoning was influenced by more than instructional strategies alone. Learner-related factors, including interest, self-efficacy, motivation, and mathematical disposition, were repeatedly identified as relevant to students' capacity to engage with mathematical problems.

Yuliani (2021), although conducted at the junior secondary level, explicitly examined mathematical reasoning ability in relation to students' learning interest and provided supporting evidence for considering interest as a learner-related factor in mathematical reasoning. More directly within elementary education, Gulo et al. (2024) examined self-efficacy and mathematical disposition in relation to mathematical reasoning, while Regita and Wahyudin (2024) investigated the connection between mathematical self-efficacy and reasoning among elementary students. These studies suggested that students' internal characteristics could interact with their ability to explain, justify, connect, and solve mathematical problems.

The reasoning literature also demonstrated that mathematical reasoning required students to become actively involved in mathematical tasks. Saleh et al. (2018) showed the relevance of realistic mathematics education for improving elementary students' reasoning ability, while Nuraeni et al.

(2019) reported the contribution of Predict–Observe–Explain learning to mathematical reasoning. Sholikhah and Chamidah (2022) further emphasized the role of habitual exposure to higher-order-thinking problems in developing mathematical reasoning. Within this broader evidence, learning interest could be interpreted as a condition that supports students’ willingness to engage repeatedly with cognitively demanding tasks.

2) Patterns of Association with Mathematical Reasoning

The synthesis showed that the relationship between learning interest and mathematical reasoning was generally positive but indirect and context-dependent. The literature did not establish that interest alone automatically produced stronger reasoning ability. Instead, interest appeared to operate together with instructional approaches, self-efficacy, mathematical disposition, task characteristics, and opportunities for meaningful problem solving.

This pattern was evident in the reasoning studies. Smit et al. (2023) examined formative feedback and the mediating role of self-efficacy in supporting primary students’ mathematical reasoning practice. Gulo et al. (2024) identified the relevance of self-efficacy and mathematical disposition, while Regita and Wahyudin (2024) connected mathematical self-efficacy with reasoning. These findings indicated that students’ willingness and confidence to engage with mathematical tasks could form part of the conditions supporting reasoning development.

Nurbaya et al. (2022) further demonstrated the relevance of numerical literacy activities within a problem-based learning environment for elementary students’ mathematical reasoning. Jusmawati et al. (2021) similarly examined creative problem-solving worksheets for reasoning ability. Meanwhile, Vessonen et al. (2024), through a systematic review and meta-analysis, showed that characteristics of mathematical word problems were associated with elementary students’ problem-solving performance. Taken together, these studies indicated that reasoning developed through the interaction of learner characteristics and cognitively appropriate learning tasks.

The literature therefore suggested a conceptual sequence in which learning interest could encourage engagement with mathematical activities, sustained engagement could increase opportunities to encounter challenging mathematical tasks, and repeated participation in such tasks could support reasoning development. However, this sequence represented a synthesis of patterns across studies rather than a causal finding established uniformly by all 35 studies.

3) Supporting Instructional Conditions

The reviewed literature identified several instructional conditions that appeared to support both learning interest and mathematical reasoning. The first was active and contextual learning. Realistic mathematics education, problem-based learning, cooperative learning, and concrete or manipulative activities provided opportunities for students to interact directly with mathematical ideas. Saleh et al. (2018) and Herzamzam (2018) illustrated the relevance of realistic mathematics education to reasoning and interest, respectively.

The second condition was cognitively stimulating mathematical tasks. Sholikhah and Chamidah (2022) emphasized the importance of high-order-thinking questions, while Nuraeni et al. (2019), Nurbaya et al. (2022), and Jusmawati et al. (2021) demonstrated the relevance of structured problem-solving activities to mathematical reasoning. These studies suggested that interest was more educationally meaningful when it was accompanied by opportunities to think, explain, justify, and solve problems.

The third condition was supportive feedback and learner confidence. Smit et al. (2023), Gulo et al. (2024), and Regita and Wahyudin (2024) indicated that self-efficacy and related learner characteristics were important in understanding reasoning performance. Thus, instructional environments that encouraged participation, provided appropriate feedback, and supported

students' confidence could create conditions in which interest was translated into sustained mathematical engagement.

Overall, the analysis of the 35 studies indicated that student learning interest constituted an important learner-related dimension in elementary mathematics education, but its relationship with mathematical reasoning was embedded within a broader instructional and motivational system. Interest was associated with participation, persistence, and mathematics learning outcomes, while reasoning was associated with active engagement in meaningful and cognitively demanding tasks. The strongest synthesis emerging from the literature was therefore not a simple direct relationship between interest and reasoning, but an interconnected pattern in which instructional conditions fostered interest and engagement, while sustained engagement created opportunities for the development of mathematical reasoning.

3. Integrated Relationships among Concrete Learning Media, Learning Interest, and Mathematical Reasoning

The integrated analysis of the 35 studies published between 2014 and 2024 showed that concrete learning media, student learning interest, and mathematical reasoning were rarely examined as completely independent dimensions. Although most studies concentrated on one or two of these variables, their findings revealed several points of intersection. Concrete media primarily represented an instructional dimension, learning interest represented a learner-related dimension, and mathematical reasoning represented an important cognitive learning outcome. When considered together, the literature suggested that meaningful instructional experiences could stimulate students' interest and engagement, while sustained engagement could provide opportunities for students to develop mathematical reasoning.

a. Interrelationships among the Three Dimensions

1) Concrete Media and Student Learning Interest

The reviewed literature indicated that concrete learning media could create learning conditions that supported students' interest and active participation in mathematics. Concrete objects enabled students to see, touch, manipulate, and experiment with mathematical representations, thereby making learning activities more interactive than approaches based primarily on symbolic explanation. Studies by Setyawan and Sarwindae (2018), Hayati (2019), Harmayanti et al. (2022), and Wahyuni et al. (2022) demonstrated the use of concrete or manipulative materials to make elementary mathematics learning more active and accessible.

This pattern was consistent with studies examining realistic and contextual mathematics education. Herzamzam (2018) reported increased mathematics learning interest through realistic mathematics education, while Kusumaningrum and Nuriadin (2022) examined concrete media within a realistic mathematics learning context. These findings suggested that the contribution of concrete media to interest was particularly meaningful when the materials were connected to understandable mathematical situations rather than used simply as physical objects.

The international literature provided a similar indication. Horan and Carr (2018) examined the role of manipulatives in early mathematics learning, while Quane (2024) investigated students' attitudes toward mathematics and pedagogical practices involving mathematical manipulatives. Siller and Ahmad (2024) further demonstrated the relevance of blended concrete and virtual manipulative instruction. Collectively, these studies suggested that concrete materials could provide an experiential learning environment in which students were encouraged to participate more actively.

However, the synthesis also showed that concrete media did not automatically generate learning interest. Their contribution depended on the way teachers organized activities, selected

appropriate materials, provided guidance, and connected manipulation with mathematical meaning. Thus, concrete media appeared to function as a facilitator of interest rather than as an independent determinant of students' motivation.

2) Learning Interest and Mathematical Reasoning

The relationship between learning interest and mathematical reasoning was more indirect than the relationship between concrete media and learning activities. The reviewed literature indicated that students who were interested in mathematics were more likely to participate actively, sustain attention, and engage with mathematical tasks. These behaviors created greater opportunities for students to practice reasoning, explaining, representing, and solving mathematical problems.

Du et al. (2021) demonstrated reciprocal relationships among mathematics interest, self-efficacy, anxiety, and achievement among primary students, providing evidence that interest was embedded within a broader motivational system. Wong and Wong (2019) similarly connected interest with mathematics performance in a technology-enhanced learning context. In Indonesian elementary education, Rofiqoh et al. (2020), Herzamzam (2018), and Pratiwi et al. (2018) provided evidence concerning the relevance of learning interest and learning conditions to mathematics learning.

The reasoning-focused literature strengthened this interpretation. Saleh et al. (2018), Nuraeni et al. (2019), Sholikhah and Chamidah (2022), Nurbaya et al. (2022), and Jusmawati et al. (2021) demonstrated that active, contextual, problem-oriented, or higher-order learning activities could support mathematical reasoning. Smit et al. (2023) further showed the relevance of formative feedback and self-efficacy in mathematical reasoning practice, while Gulo et al. (2024) and Regita and Wahyudin (2024) highlighted the importance of learner-related factors in reasoning.

Accordingly, the integrated evidence suggested that learning interest could support reasoning through a participation–engagement–practice pathway. Interest could encourage students to participate and persist, engagement could increase exposure to challenging mathematical tasks, and repeated engagement could create opportunities for reasoning development. Nevertheless, the literature did not justify interpreting interest as a direct or sufficient cause of mathematical reasoning ability.

3) Concrete Media and Mathematical Reasoning

The third relationship concerned the connection between concrete learning media and mathematical reasoning. The reviewed studies indicated that manipulatives and concrete representations could support reasoning by giving students opportunities to construct, examine, compare, and explain mathematical relationships.

Hidayah et al. (2018) demonstrated the relevance of manipulatives and question sequences in elementary solid-geometry learning. Lafay et al. (2019) found evidence concerning the use of manipulatives in mathematics interventions for children with mathematics learning difficulties. More recent evidence from Siller and Ahmad (2024) showed the relevance of combining concrete and virtual manipulatives, while Vallejo-Vargas and Reid (2024) extended the discussion to mathematical argumentation in a virtual-manipulative context.

Indonesian studies similarly indicated that concrete and contextual learning could support mathematical thinking beyond basic procedural performance. Kusumaningrum and Nuriadin (2022) connected realistic mathematics education assisted by concrete media with mathematical representation, while Hartati (2022) emphasized contextual mathematics through ethnomathematical approaches. Saleh et al. (2018) further demonstrated the contribution of realistic mathematics education to elementary students' reasoning ability.

The synthesis therefore suggested that concrete media could contribute to reasoning by providing representational and exploratory support. Students could first manipulate or observe concrete representations and subsequently use those experiences to formulate mathematical relationships, explanations, and generalizations. However, this transition depended on instructional mediation. Without questioning, reflection, explanation, and movement toward symbolic representation, manipulation alone might remain at the level of physical activity rather than mathematical reasoning.

b. Comparative Synthesis of SD and MI

1) Common Patterns across the Two Educational Contexts

The comparison of SD and MI studies revealed several common patterns. First, both educational contexts used concrete learning media to make abstract mathematical concepts more accessible. Materials were employed particularly in arithmetic, geometry, number learning, representation, and other topics in which students benefited from visual or physical representations.

Second, both SD and MI literature emphasized the importance of active student participation. Concrete materials, contextual problems, realistic mathematics, and structured learning activities were used to move students from passive reception toward active engagement. This pattern was consistent with findings from Setyawan and Sarwindae (2018), Hayati (2019), Hidayah et al. (2018), and Kusumaningrum and Nuriadin (2022).

Third, the two contexts showed a similar relationship between learner engagement and mathematical learning. Learning interest was associated with participation and learning outcomes, while mathematical reasoning was supported by opportunities to engage with challenging and meaningful tasks. Rofiqoh et al. (2020), Du et al. (2021), Smit et al. (2023), and Nurbaya et al. (2022) collectively supported this broader pattern.

Thus, across both SD and MI, the literature suggested an interconnected instructional pattern: Concrete Learning Experiences → Greater Opportunities for Engagement → Sustained Mathematical Participation → Development of Mathematical Understanding and Reasoning. This pattern should be understood as a synthesis across studies rather than as a causal model tested directly by all 35 studies.

2) Context-Specific Differences

Despite these similarities, the reviewed literature revealed differences in research emphasis and contextual implementation. The SD literature was comparatively diverse in its treatment of concrete media, learning interest, and reasoning. Studies examined manipulatives, realistic mathematics education, cooperative learning, technology-enhanced learning, problem-based learning, feedback, self-efficacy, and higher-order-thinking tasks.

The MI literature, by comparison, showed a stronger tendency toward contextual, realistic, culturally relevant, and institutionally specific approaches. Al-Bidayah (2020), for example, examined realistic mathematics-oriented thinking in Madrasah Ibtidaiyah, while Harmayanti et al. (2022) developed a Montessori-based concrete learning medium in Lombok. Hartati (2022) further demonstrated the relevance of ethnomathematical and contextual perspectives.

The difference therefore appeared less as a fundamental difference in students' responses and more as a difference in the ways mathematics instruction and research were framed. SD studies more frequently focused on particular instructional interventions and measurable learning outcomes, whereas MI-related literature more visibly incorporated contextual, realistic, Montessori, or culturally situated dimensions.

The comparison should nevertheless be interpreted cautiously because the number, methodological characteristics, research topics, and geographical distribution of SD and MI studies were not equivalent. Consequently, the available literature did not support broad claims that one educational context consistently produced stronger outcomes than the other.

3) Emerging Patterns and Research Limitations

The integrated synthesis revealed three important emerging patterns. First, concrete learning media appeared to function most meaningfully when integrated with active pedagogy. Studies involving manipulatives increasingly moved beyond the simple presentation of objects toward exploration, questioning, representation, problem solving, and mathematical argumentation (Hidayah et al., 2018; Quane, 2024; Vallejo-Vargas & Reid, 2024).

Second, learning interest appeared to serve as a connecting learner-related factor. Concrete and contextual learning experiences could support engagement, while interest could encourage students to participate and persist in mathematics learning. This participation created opportunities for students to encounter reasoning-oriented tasks. The relationship was therefore more appropriately understood as interconnected rather than linear.

Third, mathematical reasoning emerged as a higher-level outcome that depended on both instructional and learner conditions. Studies by Saleh et al. (2018), Nuraeni et al. (2019), Sholikhah and Chamidah (2022), Smit et al. (2023), Nurbaya et al. (2022), Gulo et al. (2024), and Regita and Wahyudin (2024) indicated that reasoning was associated with instructional design, task characteristics, feedback, self-efficacy, mathematical disposition, and opportunities for active problem solving.

Despite these converging patterns, several limitations in the existing literature became apparent. Most studies examined concrete media, learning interest, or mathematical reasoning separately, while relatively few investigated all three dimensions within a single research design. The literature was also dominated by intervention studies or correlational investigations conducted within particular schools, grade levels, or mathematics topics. Comparative research explicitly examining SD and MI within the same analytical framework remained limited. Furthermore, the available studies varied considerably in instruments, outcome measures, instructional models, and research designs, making direct comparison difficult.

Another limitation concerned the direction of relationships among the three dimensions. Although the literature suggested that concrete learning experiences could support engagement and that interest could be associated with mathematical learning and reasoning, relatively few studies directly tested whether concrete media influenced reasoning through changes in learning interest. Consequently, the existing evidence supported an integrated conceptual relationship but did not establish a uniform causal mechanism.

Overall, the 35-study synthesis indicated that the three dimensions could be understood as interconnected components of elementary mathematics education: concrete learning media represented an instructional resource, learning interest represented an engagement-related learner factor, and mathematical reasoning represented a central cognitive outcome. The comparative evidence from SD and MI further suggested substantial commonality in these relationships while also revealing contextual differences in instructional emphasis. This integrated pattern provided the basis for examining the three dimensions together rather than treating them as isolated components of mathematics learning.

4. Integrated Findings and Conceptual Synthesis

The synthesis of the 35 studies published between 2014 and 2024 demonstrated that concrete learning media, student learning interest, and mathematical reasoning could be

understood as interconnected dimensions of mathematics education at the elementary level. Although the reviewed studies varied in research design, educational setting, mathematical topic, and outcome measures, their findings converged around the importance of meaningful learning experiences, active student participation, and opportunities for higher-order mathematical thinking. The synthesis therefore moved beyond the findings of individual studies to identify a broader conceptual pattern applicable to both SD and MI.

a. Converging Evidence across the Literature

1) Instructional Dimension: Concrete Learning Media

The first converging dimension concerned the role of concrete learning media as an instructional resource. Across the reviewed studies, concrete objects, manipulatives, Montessori materials, contextual objects, and other physical representations were used to help students connect abstract mathematical concepts with observable experiences. Hidayah et al. (2018) demonstrated the relevance of manipulatives in solid-geometry learning, while Horan and Carr (2018) examined the role of manipulatives in early mathematics instruction. Lafay et al. (2019) further synthesized evidence concerning manipulative-based interventions for children experiencing mathematics learning difficulties.

The same pattern appeared in Indonesian elementary mathematics research. Setyawan and Sarwindae (2018), Hayati (2019), Harmayanti et al. (2022), Wahyuni et al. (2022), and Kusumaningrum and Nuriadin (2022) demonstrated different applications of concrete or contextual media in mathematics learning. These studies collectively indicated that concrete media could support conceptual understanding by enabling students to manipulate, visualize, compare, and represent mathematical relationships.

Recent studies also suggested that the role of manipulatives could extend beyond basic conceptual understanding. Siller and Ahmad (2024) examined concrete and virtual manipulative instruction, while Vallejo-Vargas and Reid (2024) connected manipulative environments with mathematical argumentation. Quane (2024) further highlighted the relationship between pedagogical practice and attitudes toward mathematics in the use of mathematical manipulatives. Thus, the evidence suggested that concrete media could serve as a foundation for both conceptual and cognitively demanding mathematical activity when appropriately integrated into instruction.

2) Learner Dimension: Student Learning Interest

The second converging dimension concerned student learning interest as a learner-related component of mathematics education. The reviewed studies consistently indicated that interest was associated with students' participation, engagement, learning experiences, and, in several studies, mathematics learning outcomes.

Du et al. (2021) provided particularly relevant evidence by demonstrating reciprocal relationships among mathematics interest, anxiety, self-efficacy, and achievement among primary school students. Wong and Wong (2019) similarly examined the relationship between mathematics interest and performance in a technology-enhanced learning context. Within Indonesian elementary education, Rofiqoh et al. (2020), Herzamzam (2018), and Pratiwi et al. (2018) showed the relevance of learning interest and learning conditions to mathematics learning.

The literature further indicated that interest was not simply a stable student characteristic. It could be influenced by instructional experiences, learning environments, task characteristics, and opportunities for active participation. Studies conducted under different learning conditions, including Oktavia et al. (2020) and Prastitasari et al. (2022), demonstrated that changes in instructional contexts could be associated with differences in students' mathematics interest.

Consequently, the synthesis positioned learning interest as an engagement-related learner factor that could connect instructional experiences with students' willingness to participate and persist in mathematics learning.

3) Outcome Dimension: Mathematical Reasoning

The third converging dimension was mathematical reasoning, which emerged as an important higher-order outcome of mathematics learning. Across the reviewed literature, reasoning was associated with students' abilities to identify relationships, provide explanations, represent mathematical ideas, solve problems, justify solutions, and engage with higher-order mathematical tasks.

Saleh et al. (2018) demonstrated the contribution of realistic mathematics education to elementary students' reasoning ability, while Nuraeni et al. (2019) examined Predict–Observe–Explain learning in relation to mathematical reasoning. Sholikhah and Chamidah (2022) emphasized the role of higher-order-thinking questions, and Nurbaya et al. (2022) examined numerical literacy activities in a problem-based learning environment. Jasmawati et al. (2021) likewise demonstrated the relevance of creative problem-solving worksheets to reasoning ability.

The literature also showed that reasoning was influenced by learner-related and instructional conditions. Smit et al. (2023) examined formative feedback and self-efficacy in mathematical reasoning practice, while Gulo et al. (2024) and Regita and Wahyudin (2024) identified relationships involving self-efficacy, mathematical disposition, and reasoning. Vessonen et al. (2024) further demonstrated that task characteristics were relevant to elementary students' mathematical problem-solving performance.

Taken together, these findings positioned mathematical reasoning not merely as a result of exposure to mathematics content but as an outcome emerging from appropriate tasks, instructional support, and active learner engagement.

b. Emerging Conceptual Pattern

1) Concrete Learning Media as an Instructional Support

The integrated evidence indicated that concrete learning media were most appropriately understood as instructional support rather than an independent determinant of learning outcomes. Their value emerged when physical materials were connected with mathematical questioning, exploration, representation, discussion, and reflection.

The literature suggested a movement from concrete experience toward mathematical representation and abstraction. Students could first manipulate objects, observe relationships, and construct representations before expressing mathematical ideas through symbols or formal reasoning. This pattern was evident across studies involving manipulatives, realistic mathematics education, Montessori materials, and contextual mathematics learning.

Accordingly, concrete media appeared to provide the initial instructional conditions through which students could encounter mathematical concepts in accessible and meaningful ways. However, the transition from manipulation to understanding depended on teacher guidance and the design of learning activities. The physical presence of concrete materials alone was therefore insufficient to explain differences in mathematical outcomes.

2) Learning Interest as an Engagement-Related Factor

The second component of the emerging conceptual pattern was student learning interest as an engagement-related factor. The literature suggested that when students found mathematics meaningful, accessible, or interesting, they were more likely to participate actively and sustain attention during learning activities.

Interest could therefore function as a connecting mechanism between instructional experience and student participation. Concrete materials, contextual problems, realistic mathematics, cooperative activities, and supportive learning environments could contribute to students' engagement, while engagement could provide opportunities for sustained practice.

The evidence from Du et al. (2021), Wong and Wong (2019), Herzamzam (2018), and Rofiqoh et al. (2020) suggested that interest and mathematics learning could also influence one another. Consequently, interest was more appropriately interpreted as part of a dynamic learning process rather than as a fixed learner characteristic.

3) Mathematical Reasoning as a Higher-Order Learning Outcome

The third component was mathematical reasoning as a higher-order learning outcome. The reviewed studies indicated that reasoning required more than the ability to recall procedures or obtain correct numerical answers. It involved interpreting mathematical situations, identifying relationships, constructing representations, explaining ideas, justifying solutions, and solving non-routine or cognitively demanding problems.

The synthesis suggested that mathematical reasoning developed when students were given opportunities to move beyond procedural repetition toward exploration, problem solving, argumentation, and explanation. Concrete learning media could support this process by providing representations, while learning interest could encourage students to remain engaged with challenging tasks.

The resulting conceptual relationship could therefore be expressed as:

Concrete Learning Media → Meaningful Mathematical Experiences → Student Learning Interest and Engagement → Sustained Mathematical Activity → Mathematical Reasoning. This sequence represents the integrated pattern identified through the literature synthesis, rather than a causal model empirically tested across all 35 studies.

c. Overall Synthesis of the 35 Studies

1) Major Findings

Three major findings emerged from the overall synthesis. First, concrete learning media were consistently associated with more accessible and experiential mathematics learning, particularly when students needed support in understanding abstract mathematical concepts. Second, student learning interest was consistently connected with participation, engagement, and mathematics learning, although its relationship with achievement and reasoning varied according to instructional and learner conditions. Third, mathematical reasoning was supported by active, contextual, problem-oriented, and higher-order learning activities, with both instructional and learner-related factors contributing to the learning conditions in which reasoning could develop.

The three dimensions therefore represented different but complementary components of mathematics education: concrete media provided instructional support, learning interest supported engagement, and mathematical reasoning represented an important cognitive outcome.

2) Consistent and Divergent Evidence

The most consistent evidence across the literature concerned the importance of active and meaningful mathematics learning. Studies from both international and Indonesian contexts generally indicated that students benefited when mathematical concepts were connected to concrete representations, contextual situations, active participation, and cognitively demanding tasks.

However, the evidence was not completely uniform. Studies differed in the magnitude and type of outcomes associated with concrete media, learning interest, and instructional interventions. Some studies emphasized achievement or conceptual understanding, whereas others focused on

representation, engagement, problem solving, argumentation, or reasoning. Differences were also evident in the role of learner characteristics such as self-efficacy, mathematical disposition, anxiety, and interest.

The literature therefore did not support a simple claim that one instructional resource or learner characteristic consistently determined mathematical reasoning. Instead, the findings indicated that outcomes were shaped by interactions among instructional design, learner characteristics, mathematical tasks, and educational context.

3) Implications for Mathematics Education in SD and MI

The synthesis has several implications for mathematics education in SD and MI. First, concrete learning media should be integrated into purposeful mathematical activities rather than being used merely as supplementary classroom objects. Teachers can use manipulatives and contextual materials to help students construct representations, explain relationships, and gradually move toward abstract mathematical reasoning.

Second, mathematics instruction should create conditions that support student learning interest and sustained engagement. Meaningful contexts, active learning, collaborative activities, appropriate challenges, and supportive feedback can provide opportunities for students to remain involved in mathematical tasks.

Third, mathematical reasoning should be developed through deliberate exposure to problem solving, explanation, justification, representation, and higher-order-thinking activities. The literature suggests that reasoning is unlikely to develop fully when students are restricted to procedural practice alone.

Finally, the comparison between SD and MI indicates that these principles can be applied across both educational contexts while allowing for contextual adaptation. The MI literature particularly highlights the potential value of contextual, realistic, culturally meaningful, and locally available learning resources, whereas SD research demonstrates a broad range of instructional applications. The central implication is therefore not the adoption of a single instructional model, but the development of an integrated mathematics-learning environment in which concrete experiences, student interest, and mathematical reasoning reinforce one another.

Overall, the 35-study synthesis supports a conceptual understanding of elementary mathematics learning as an interconnected process in which instructional resources create meaningful learning opportunities, learner interest sustains engagement, and sustained engagement provides the conditions for higher-order mathematical reasoning. This integrated perspective also identifies a clear area for further research: the need for studies that examine the three dimensions simultaneously and compare their relationships systematically across SD and MI contexts.

DISCUSSION

1. Results Analysis

This study aimed to critically synthesize the literature on concrete learning media, student learning interest, and mathematical reasoning in elementary and Madrasah Ibtidaiyah (MI) mathematics education, while identifying similarities, differences, and interrelationships across the two educational contexts. The synthesis of 35 studies indicates that these three dimensions should not be understood as isolated components of mathematics learning. Rather, the literature reveals an interconnected instructional pattern in which concrete learning media provide meaningful mathematical experiences, learning interest supports students' sustained participation in those experiences, and continued engagement creates opportunities for the development and expression of mathematical reasoning. The central finding of the review is therefore not simply that concrete media, learning interest, and reasoning are individually important, but that their educational

significance becomes more visible when they are interpreted as interconnected instructional, learner, and outcome dimensions.

The first important finding concerns the role of concrete learning media as an instructional support for mathematical learning. Across the reviewed literature, concrete and manipulative materials appear to reduce the distance between abstract mathematical concepts and students' immediate learning experiences. Their significance extends beyond making lessons more attractive or providing physical objects for classroom activities. Concrete materials can function as mediational resources through which students observe relationships, manipulate quantities, represent mathematical ideas, and gradually move from perceptual experiences toward more formal mathematical representations. This interpretation is consistent with studies emphasizing the instructional contribution of concrete learning experiences to mathematical understanding (Setyawan & Sarwindae, 2018; Horan & Carr, 2018; Quane, 2024). Thus, the value of concrete media lies primarily in the quality of mathematical activity that they facilitate rather than in the physical objects themselves.

The second finding indicates that student learning interest represents an important learner-related dimension within this instructional process. The reviewed studies suggest that interest is reflected not merely in students' initial willingness to participate, but also in their attention, involvement, persistence, and readiness to continue engaging with mathematical tasks. This interpretation is important because concrete learning experiences do not automatically produce meaningful learning outcomes. Their potential depends partly on whether students interact with the materials actively and remain engaged with the mathematical problem or task. In this sense, learning interest can be interpreted as an engagement-related condition that helps sustain students' participation in learning activities (Herzamzam, 2018; Pratiwi et al., 2018; Ernawati et al., 2020). The synthesis therefore positions interest between instructional support and sustained learning activity rather than treating it simply as an independent student characteristic.

The third finding concerns mathematical reasoning as a higher-order learning outcome. The reviewed literature suggests that reasoning develops when students are provided with opportunities to identify patterns, make connections, explain relationships, justify procedures, and interpret mathematical situations. Consequently, reasoning should not be reduced to the ability to obtain a correct numerical answer. It represents a broader process through which students construct, communicate, and justify mathematical meaning. The literature on elementary mathematics learning reviewed in this study indicates that reasoning becomes more meaningful when students are actively involved in mathematical experiences rather than merely receiving procedural explanations. This interpretation is consistent with the emphasis in previous studies on meaningful mathematical activity, conceptual understanding, and the development of higher-order mathematical processes (Nuraeni et al., 2019; Kusumaningrum & Nuriadin, 2022; Nurbaya et al., 2022).

Taken together, these findings directly address the first objective of the review concerning the role and patterns of concrete learning media in SD and MI mathematics education. They also address the second objective concerning student learning interest and its relationship to mathematical reasoning. More importantly, they provide an interpretive answer to the broader objective of examining how instructional and learner dimensions are connected to mathematical outcomes. The evidence suggests a conceptual sequence in which concrete learning media → meaningful mathematical experiences → student learning interest and engagement → sustained mathematical activity → mathematical reasoning. This sequence should be understood as an emerging pattern from the reviewed literature rather than as a statistically established causal

pathway. Its analytical value lies in showing how findings that are frequently examined separately can be interpreted as parts of a broader learning process.

The relationship among the three dimensions is particularly important for understanding why individual instructional interventions may produce different outcomes across learning contexts. Concrete materials can create opportunities for exploration, but opportunities alone do not guarantee sustained engagement. Similarly, students may demonstrate interest in an activity without necessarily developing deeper mathematical reasoning if the activity does not require them to explain, connect, justify, or reflect on mathematical ideas. Reasoning therefore appears to emerge from the interaction between the availability of meaningful instructional experiences and students' sustained cognitive engagement with those experiences. The critical synthesis consequently shifts the analytical focus from the question of whether concrete media are effective toward the more important question of how concrete learning experiences are transformed into sustained mathematical activity and reasoning.

This interpretation can also be theoretically understood through the learner-centered orientation reflected in the reviewed literature. Concrete learning experiences provide students with opportunities to interact directly with mathematical objects and representations, while interest supports their willingness to remain involved in the learning process. Mathematical reasoning then represents a more advanced form of engagement in which students organize experiences into explanations, relationships, patterns, and justifications. In this perspective, learning is not merely the transmission of mathematical information but a process of constructing mathematical meaning through activity and reflection. The findings concerning concrete learning experiences and student engagement are therefore consistent with the broader educational emphasis on active participation and meaningful learning represented in the studies reviewed (Hidayah et al., 2018; Siller & Ahmad, 2024; Vallejo-Vargas & Reid, 2024).

An additional analytical finding emerges from the comparison between SD and MI contexts. Although the reviewed studies indicate substantial similarities in the instructional value of concrete media, the implementation of learning activities is shaped by contextual characteristics, including instructional practices, learning environments, and the orientation of educational institutions. This suggests that the three-dimensional relationship identified in the synthesis should not be interpreted as a uniform instructional formula. Instead, concrete media, student interest, and mathematical reasoning constitute interconnected dimensions whose expression may vary according to the context in which mathematics learning occurs. The comparison between SD and MI therefore strengthens the argument that instructional media should be examined not only in terms of their physical form but also in relation to how teachers organize learning activities and how students are encouraged to participate in them.

The most important new synthesis of this review is therefore the identification of a mediated instructional-learning pathway. Concrete learning media occupy the instructional position, learning interest represents an engagement-related learner condition, and mathematical reasoning constitutes the higher-order outcome dimension. The three dimensions are connected through meaningful mathematical activity and sustained participation. This synthesis contributes a more integrated interpretation of the literature because it moves beyond examining concrete media, interest, and reasoning as separate variables. At the same time, it avoids claiming that the reviewed studies collectively establish a direct causal relationship. Instead, the evidence supports a conceptual proposition that concrete learning experiences become educationally meaningful when they stimulate sustained engagement, and sustained engagement creates conditions in which mathematical reasoning can be developed and expressed. This conceptualization provides a basis

for understanding the diverse findings across SD and MI mathematics education and establishes a foundation for the subsequent discussion of the findings in relation to previous studies, theoretical contributions, practical implications, and limitations.

2. Comparison with Previous Studies

The findings of this review demonstrate substantial consistency with previous studies concerning the instructional value of concrete learning media in elementary mathematics education. Earlier research has generally indicated that concrete materials and manipulatives can support students in understanding mathematical concepts by connecting abstract ideas with observable and manipulable experiences (Setyawan & Sarwindae, 2018; Horan & Carr, 2018; Hidayah et al., 2018). The present synthesis extends this understanding by indicating that the contribution of concrete media is not adequately represented by their ability to facilitate conceptual understanding alone. Across the reviewed literature, their instructional value is more appropriately interpreted in relation to the mathematical activities that they generate, including exploration, representation, comparison, pattern recognition, and explanation. Thus, the present findings reinforce previous evidence while extending the analytical focus from the *presence of concrete materials* to the *quality of learning experiences mediated by those materials*.

This interpretation is also consistent with more recent literature emphasizing the importance of meaningful and active mathematical experiences. Quane (2024), Siller and Ahmad (2024), and Vallejo-Vargas and Reid (2024) highlight the continuing relevance of concrete or representational approaches for supporting mathematical learning. The present synthesis, however, indicates that the instructional contribution of such media is context-dependent. Concrete materials do not function as pedagogical solutions independently of instructional design. Their contribution becomes more meaningful when students are required to interact with mathematical ideas, communicate their thinking, and connect concrete representations with more formal mathematical concepts. This finding is important because it qualifies a simple interpretation of the literature in which the use of manipulatives is automatically equated with improved mathematical learning.

The findings concerning student learning interest similarly converge with previous research that identifies interest as an important factor in students' participation and mathematics learning. Studies by Herzamzam (2018), Pratiwi et al. (2018), Ernawati et al. (2020), and Oktavia et al. (2020) indicate that students' interest is associated with their involvement in learning activities and their learning outcomes. The present review supports this general pattern but provides a more relational interpretation. Rather than positioning interest solely as an internal learner characteristic, the synthesis suggests that interest can be strengthened or weakened by the instructional experiences provided to students. In particular, concrete and accessible learning activities may create conditions that encourage attention, participation, and persistence. This interpretation extends previous findings by placing student interest within an interaction between instructional conditions and learner engagement.

The relationship between learning interest and mathematical reasoning also shows both convergence and analytical extension. Previous studies have examined mathematical reasoning, conceptual understanding, and related higher-order mathematical competencies as important outcomes of elementary mathematics learning (Nuraeni et al., 2019; Kusumaningrum & Nuriadin, 2022; Nurbaya et al., 2022). Other studies have focused more directly on students' learning motivation, interest, or engagement. The present synthesis brings these strands of research into a common analytical framework. It suggests that interest is relevant to reasoning not because interest itself constitutes reasoning, but because sustained interest can support continued participation in mathematical activities through which reasoning is practiced. This distinction is significant because

it avoids interpreting a positive relationship between interest and learning outcomes as a direct or automatic causal effect.

The findings are further consistent with studies emphasizing that mathematical reasoning develops through opportunities for students to engage with mathematical relationships rather than merely reproduce procedures. Research reviewed in the present study indicates that students require learning environments in which they can explore, identify patterns, make connections, explain their thinking, and justify solutions (Nuraeni et al., 2019; Kusumaningrum & Nuriadin, 2022; Nurbaya et al., 2022). The current synthesis extends this position by identifying concrete learning experiences and student interest as potentially complementary conditions within that process. Concrete media can provide an experiential entry point, whereas interest can support sustained participation; reasoning emerges as the dimension that requires students to transform those experiences into mathematical explanations and relationships.

At the same time, the review reveals differences in emphasis across previous studies. Some studies primarily investigate the effectiveness of a particular instructional medium, learning model, or classroom intervention, whereas others focus on learner characteristics such as motivation, interest, or engagement. Studies such as Gulo et al. (2024), Regita and Wahyudin (2024), and Meirisa et al. (2021) illustrate the diversity of approaches used to examine mathematics learning and learner-related factors. Consequently, the evidence base is fragmented across different instructional and learner dimensions. The contribution of the present review is to bring these strands together rather than treating them as independent research domains. This integrative approach makes visible a pattern that may remain less apparent when concrete media, learning interest, and mathematical reasoning are investigated separately.

The comparison also indicates that findings across studies should not be interpreted as completely uniform. Differences in instructional settings, student characteristics, learning objectives, types of media, and classroom implementation may influence the extent to which concrete learning experiences support students' mathematical engagement and reasoning. The reviewed literature therefore provides stronger support for a contextual and relational interpretation than for a universal instructional effect. This observation is particularly relevant to the comparison between elementary schools (SD) and Madrasah Ibtidaiyah (MI). Although the two contexts share fundamental characteristics of elementary mathematics learning, the organization of instruction and institutional context may shape how instructional media are selected, implemented, and connected to students' learning experiences.

The SD–MI comparison also adds an important dimension that is less visible in studies concentrating on single educational settings. The similarities identified across the literature suggest that the underlying educational functions of concrete learning experiences, student engagement, and mathematical reasoning are broadly relevant to both contexts. However, differences in implementation indicate that instructional practices cannot be transferred mechanically from one setting to another. The findings therefore support a contextualized interpretation in which the same instructional resource may serve different pedagogical functions depending on teacher mediation, classroom organization, student characteristics, and institutional expectations. This finding complements previous literature while drawing attention to the need for comparative research across educational contexts.

A further point of comparison concerns the relationship between concrete learning media and higher-order mathematical outcomes. Previous research has frequently examined concrete media in relation to conceptual understanding, achievement, or students' immediate learning responses (Setyawan & Sarwindae, 2018; Hidayah et al., 2018; Horan & Carr, 2018). The present

review broadens this perspective by connecting concrete learning experiences with mathematical reasoning through the intermediate dimension of sustained engagement. This does not imply that concrete media directly produce reasoning. Rather, the synthesis suggests that their potential contribution to reasoning becomes more plausible when the instructional environment enables students to remain actively engaged in mathematical activity. In this respect, the present study provides an interpretive bridge between literature on instructional resources and literature on learner engagement and higher-order mathematical outcomes.

Overall, the comparison with previous studies demonstrates both confirmation and extension. The findings confirm the established importance of concrete learning experiences, student interest, and mathematical reasoning identified across the literature. However, they extend previous work by integrating these dimensions into a single comparative framework encompassing SD and MI mathematics education. The resulting synthesis can be expressed as concrete learning experiences → increased opportunities for engagement → sustained mathematical participation → development of mathematical understanding and reasoning. Compared with studies that examine individual factors independently, this formulation emphasizes the complementary roles of instructional resources, learner engagement, and higher-order learning outcomes. Its contribution is therefore primarily conceptual: it provides an integrated interpretation of dispersed evidence while recognizing that the strength and expression of these relationships remain dependent on instructional and contextual conditions.

3. Implications of Findings

The findings contribute to mathematics education literature by providing an integrated interpretation of concrete learning media, student learning interest, and mathematical reasoning as interconnected dimensions of elementary mathematics learning. Theoretically, the study extends fragmented perspectives that tend to examine instructional media, learner engagement, and mathematical outcomes separately. The proposed sequence—concrete learning experiences → engagement and sustained participation → mathematical reasoning—offers a conceptual framework for understanding how instructional and learner dimensions may operate together. Importantly, this framework is interpretive rather than causal and provides a basis for further empirical testing across different elementary and Madrasah Ibtidaiyah contexts.

Practically, the findings suggest that teachers should not select concrete learning media merely because they are attractive, familiar, or easy to use. Their instructional value depends on how they are incorporated into activities that require students to explore, communicate, compare, explain, and justify mathematical ideas. Teachers can therefore combine concrete materials with questioning, guided discussion, problem-solving, and reflective activities to encourage sustained engagement and reasoning. For schools and MI, the findings also highlight the importance of supporting teachers with appropriate learning resources and instructional planning that connects manipulatives with curriculum objectives rather than treating media as supplementary classroom accessories. For researchers, the synthesis indicates a need for empirical studies that examine the interaction among instructional media, student interest, and mathematical reasoning rather than investigating these dimensions exclusively.

4. Research Limitations

Several limitations should be considered when interpreting the findings. First, the review was based on 35 studies published between 2014 and 2024; therefore, the synthesis may not represent all available evidence on concrete learning media, student interest, and mathematical reasoning. Second, differences in research designs, participants, instruments, instructional settings, and outcome measures across the reviewed studies limited direct comparison and prevented statistical

aggregation. Third, the comparative interpretation of SD and MI contexts was constrained by the uneven availability and characteristics of studies from each educational setting. Fourth, the thematic synthesis inevitably involved researcher interpretation, although systematic selection, thematic coding, comparative analysis, and explicit synthesis procedures were used to strengthen consistency. Finally, because the study synthesized secondary evidence, the proposed relationships among concrete learning media, learning interest, and mathematical reasoning should not be interpreted as experimentally established causal effects. Future research should test the proposed conceptual pathway through longitudinal, quasi-experimental, or mixed-method designs involving diverse SD and MI populations.

CONCLUSION

This study aimed to critically synthesize the literature on concrete learning media, student learning interest, and mathematical reasoning in elementary and Madrasah Ibtidaiyah (MI) mathematics education and to identify the relationships among these dimensions across the two educational contexts. The synthesis of 35 studies published between 2014 and 2024 indicates that concrete learning media, learning interest, and mathematical reasoning are more meaningfully understood as interconnected dimensions rather than isolated components of mathematics learning. Concrete learning media provide opportunities for meaningful mathematical experiences, learning interest supports students' sustained engagement in those experiences, and sustained mathematical participation creates conditions for the development and expression of mathematical reasoning. The central contribution of the study is therefore the identification of an integrated conceptual pathway: concrete learning experiences → engagement and sustained participation → mathematical reasoning. This pathway provides a synthesized explanation of how instructional and learner-related dimensions can converge in supporting higher-order mathematics learning in both SD and MI contexts.

The review also demonstrates that similarities between SD and MI are evident in the fundamental instructional functions of concrete learning experiences and the importance of student engagement and reasoning, while differences emerge in how these elements are implemented within particular educational contexts. The findings consequently support a contextual rather than universal interpretation of instructional media. Concrete materials alone are insufficient; their educational value depends on how teachers transform them into meaningful activities that encourage exploration, interaction, explanation, and mathematical justification. In this respect, the study contributes a conceptual integration of previously dispersed strands of research and shifts attention from the isolated effectiveness of learning media toward the interaction between instructional support, learner engagement, and mathematical reasoning.

Several limitations should be acknowledged. The synthesis was restricted to 35 studies published during 2014–2024, and differences in research designs, participants, instruments, instructional settings, and outcome measures limited direct comparison across studies. The availability and characteristics of research on SD and MI were also not completely balanced, which constrains the breadth of contextual comparison. In addition, the thematic and comparative synthesis involved interpretive decisions by the researcher. Accordingly, the proposed relationship among concrete learning media, learning interest, and mathematical reasoning should be regarded as a conceptual synthesis rather than evidence of experimentally established causality.

Future research should build on this synthesis by empirically testing the proposed conceptual pathway across diverse SD and MI settings. Longitudinal, quasi-experimental, and mixed-method studies could examine how different forms of concrete learning media influence students' engagement and how sustained engagement is associated with the development of mathematical

reasoning over time. Comparative research should also examine how teacher mediation, classroom practices, institutional context, and student characteristics shape these relationships. Such research would strengthen the empirical basis of the present conceptual synthesis and contribute to the development of more context-sensitive approaches to elementary mathematics education.

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