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Innovative Approaches to Mathematics Instruction Through Historical Perspectives: A Descriptive Systematic Review

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Abstract

The integration of the history of mathematics (HOM) into mathematics instruction has gained increasing scholarly attention as educators seek approaches that deepen conceptual understanding, foster epistemological awareness, and situate mathematics within broader cultural and historical contexts. Despite this growing interest, findings regarding its pedagogical value, instructional design principles, and implementation challenges remain dispersed across diverse empirical studies. This study presents a descriptive systematic review of research published between 2000 and 2025 examining the integration of historical perspectives in mathematics education. Following PRISMA-style procedures, 18 empirical studies were identified through a multi-stage screening process based on predefined criteria. Thematic synthesis revealed that HOM integration contributes to cognitive–conceptual development, sociocultural identity formation, engagement and affective dimensions, and interdisciplinary connections, including evidence that historically structured tasks can support students’ understanding of foundational mathematical concepts by situating them within meaningful problem contexts. However, these benefits are mediated by instructional design coherence and are constrained by factors such as teacher preparation, curriculum pressures, and assessment alignment. The review suggests that HOM functions not merely as enrichment content but as a pedagogical lens capable of reshaping how mathematical knowledge and learning are conceptualized. Effective implementation therefore requires principled instructional design and systemic support across curriculum, teacher education, and assessment structures.

Keywords: History of mathematics, Mathematics education, Systematic review, Instructional design, STEAM education

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1. Introduction

In recent years, increasing attention has been given to the cultural and human dimensions of mathematics education, particularly concerning the role of the history of mathematics (HOM) in teaching and learning. As global educational agendas emphasize cultural relevance, inclusivity, and higher-order thinking, integrating historical perspectives recognized

as a promising approach for enriching students' mathematical understanding and engagement (Fried, 2008, 2018; Radford, 1997). Empirical studies have shown that historical contexts can support conceptual development, improve students' attitudes towards mathematics, and foster meaningful learning experiences (De Vittori et al., 2024; Lim & Chapman, 2015; Marshall & Rich, 2000). Foundational work in the field has long emphasised the pedagogical value of integrating historical perspectives to support conceptual understanding, epistemological awareness, and engagement, as articulated in major international syntheses and theoretical frameworks (Boyer & Merzbach, 2011; Fauvel & van Maanen, 2000; Jankvist, 2009).

While these foundational frameworks established the pedagogical and epistemological rationale for integrating historical perspectives, recent empirical research has expanded the field across diverse educational contexts and methodological approaches (e.g., Chorlay et al., 2022; De Vittori et al., 2024). Contemporary studies increasingly examine classroom-based interventions, interdisciplinary applications, and identity-oriented dimensions of learning. However, despite this growth, the expanding body of work remains analytically dispersed, with limited integrative synthesis that systematically connects cognitive, sociocultural, instructional, and implementation-related dimensions.

HOM provides insight into how mathematical ideas emerged through human inquiry, cultural exchange, and problem-solving across civilisations (Boyer & Merzbach, 2011). When incorporated into instruction, historical narratives and problems can promote cognitive reconstruction and connect abstract mathematical concepts to learners' lived experiences (Fried, 2008, 2018; Radford, 1997). From a sociocultural perspective, learning is mediated by cultural tools and historical contexts, positioning HOM as a valuable mediational resource rather than supplementary content (Vygotsky, 1978). Research has further highlighted the role of historical integration in addressing issues of cultural representation and identity, particularly in countering Eurocentric narratives and supporting inclusive mathematics classrooms (Aikenhead, 2017).

Within STEAM education, HOM addresses the need for equitable disciplinary representation of mathematics and illuminates historical synergies among mathematics and technology, the arts, science, and engineering, such as the mathematical transformations underlying traditional artistic patterns that align with STEAM's transdisciplinary goal of solving real-world problems through integrated knowledge (Belbase et al., 2022; El Bedewy et al., 2022). Building on this work, Jankvist's (2009) framework further distinguishes between the "whys" and "hows" of using history in mathematics education, highlighting the importance of aligning historical integration with clearly articulated pedagogical goals rather than treating it as incidental enrichment.

Despite these recognised benefits, the integration of HOM in classroom practice remains inconsistent and often superficial. Many mathematics curricula and textbooks continue to prioritise procedural fluency and symbolic manipulation, with limited attention given to historical development, cultural context, or interdisciplinary connections (OECD, 2025; Schmidt et al., 2022). Where historical elements are included, they frequently appear as isolated anecdotes rather than as integral components of instructional design. Studies have also reported challenges related to teachers' limited preparation in historical content, curriculum time constraints, and assessment practices that are not aligned with historically informed pedagogy (Ho, 2008; Panasuk & Horton, 2012).

While a growing body of research has examined the pedagogical use of historical perspectives in mathematics education, this work is distributed across theoretical discussions, classroom-based interventions, curriculum studies, and interdisciplinary explorations. Recent reviews and empirical studies have highlighted advances in the field, yet they also point to fragmentation in both thematic focus and methodological (Chorlay et al., [2022](#); De Vittori et al., [2024](#)). Many studies concentrate primarily on either cognitive–conceptual outcomes or sociocultural and identity dimensions without systematically linking these strands. In addition, methodological diversity, ranging from qualitative case studies to quasi-experimental and mixed-methods designs, has generated context-specific findings that are rarely synthesised across educational levels. Without an integrative synthesis that connects reported benefits, instructional design approaches, and implementation constraints, it remains unclear which forms of historical integration are associated with conceptual development, which design features support sustained engagement, and which contextual factors constrain implementation across settings.

To address this gap, the present study conducts a descriptive systematic review of research on the integration of HOM in mathematics education. The review aims to synthesise existing findings, identify key thematic patterns, and examine how historical perspectives have been employed to support learning, teaching, and curriculum development. Specifically, the review is guided by the following questions:

- a. What cognitive–conceptual, sociocultural, affective, and interdisciplinary benefits of integrating historical perspectives are supported by empirical evidence in mathematics education research?
- b. What instructional design approaches are used to incorporate historical perspectives in mathematics teaching?
- c. What challenges and constraints are identified in the implementation of history-based mathematics instruction?

By systematically analysing the literature, this review seeks to contribute a consolidated understanding of the pedagogical role of HOM and to inform future research and practice in mathematics education.

2. Method

2.1 Review Design

This study adopts a descriptive systematic review approach to synthesise existing research on the integration of HOM in mathematics education. A descriptive systematic review enables the structured identification, organisation, and synthesis of prior studies, allowing the examination of trends, instructional approaches, reported outcomes, and implementation challenges without aggregating effect sizes (Booth et al., [2016](#); Maeda et al., [2022](#)). This approach is particularly appropriate for educational research, where studies are frequently qualitative, mixed-methods, or conceptual in nature and where thematic synthesis is more suitable than statistical meta-analysis (Booth et al., [2016](#); Petticrew & Roberts, [2006](#)).

The review was designed to capture both foundational theoretical contributions and recent empirical studies in order to provide a comprehensive overview of how historical perspectives have been conceptualised and implemented in mathematics education. The descriptive orientation of the review allows for critical interpretation of patterns across studies while

maintaining transparency in the identification and selection of studies (Petticrew & Roberts, 2006). Such an approach is consistent with methodological arguments in mathematics education research that emphasise the value of synthesis-oriented and interpretive designs for examining complex classroom and curricular phenomena (Shahrill, 2017).

2.2 Search Strategy and Data Sources

A systematic literature search was conducted across multiple academic databases to ensure comprehensive and international coverage of relevant studies. The databases searched included Scopus, ScienceDirect, ERIC, and Google Scholar, which index a wide range of peer-reviewed journals and scholarly publications in mathematics education and related fields.

The search strategy was developed iteratively and refined through preliminary scoping searches. Core search terms were derived from three conceptual domains: (a) history of mathematics, (b) mathematics education, and (c) instructional and pedagogical approaches. The final set of keywords included: “history of mathematics”, “historical approach”, “historical perspectives”, “mathematics education”, “mathematics teaching”, “mathematics learning”, “instructional design”, and “STEAM education”. Boolean operators were used to combine these terms. For example, the search string used in Scopus was (TITLE-ABS-KEY (“history of mathematics” OR “historical approach to mathematics”) AND TITLE-ABS-KEY (“mathematics education” OR “mathematics teaching” OR “mathematics learning”) AND TITLE-ABS-KEY (“student” OR “learner” OR “classroom” OR “pedagogy” OR “instruction”)). Similar adaptations of the search string were applied across ScienceDirect and ERIC to account for database-specific indexing and search functionalities.

Google Scholar was used as a supplementary source to identify additional relevant studies and to ensure coverage of recent publications and highly cited works that may not yet be fully indexed in other databases. The reference lists of key review articles and seminal papers were also manually screened to identify additional potentially relevant studies. The search focused on studies published between 2000 and January 2026, capturing both foundational research and contemporary developments in the field. The search was conducted up to January 26, 2026, with additional relevant studies published online ahead of print in 2025 incorporated during the final stage of manuscript preparation.

2.3 Inclusion and Exclusion Criteria

Studies were selected based on clearly defined inclusion and exclusion criteria. To be included, a study had to be a peer-reviewed journal article, conference proceeding, or scholarly book chapter. It also had to be published between 2000 and 2025 and written in English. For book chapters, peer-reviewed status was verified separately. Chapters found through Google Scholar were cross-checked against established academic databases. Publisher credentials were also consulted, with preference given to volumes from recognised academic publishers. In terms of content, included studies had to explicitly address the use, role, or pedagogical integration of the HOM in mathematics education. They needed to focus on teaching, learning, curriculum, or instructional design. Studies conducted at primary, secondary, or tertiary education levels were all considered eligible.

Studies were excluded if they focused solely on pure mathematics or mathematical history without an educational context. Studies that did not explicitly incorporate historical

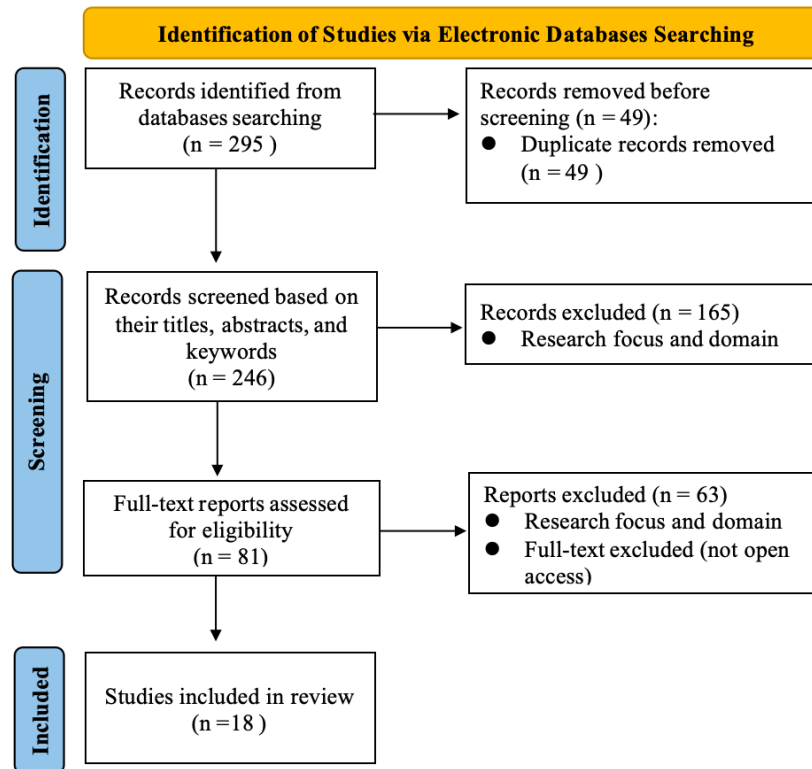


Figure 1. Flow Diagram of the Manuscript Selection Process

perspectives in relation to teaching or learning were also excluded. Opinion pieces, editorials, and non-scholarly commentary without empirical or theoretical grounding were not considered. Finally, duplicate records identified across databases were removed. These criteria were applied consistently throughout the screening process to ensure relevance and methodological appropriateness.

2.4 Screening and Selection Process

The study selection process followed a systematic, multi-stage screening procedure comprising three stages: identification, screening, and inclusion (see Figure 1 for the flow diagram). Initially, all records retrieved from database searches were compiled, and duplicates were removed using Mendeley reference management software. Screening was conducted independently by two reviewers. During the title and abstract screening stage, each reviewer assessed the relevance of studies according to the predefined inclusion and exclusion criteria. Studies that clearly did not meet the inclusion criteria were excluded at this stage. Any discrepancies between reviewers were discussed until a consensus was reached. Where necessary, a third reviewer was consulted to resolve disagreements.

Full-text versions of the remaining studies were subsequently retrieved and assessed independently by the same two reviewers. During this stage, articles were evaluated to ensure that they explicitly addressed the integration of historical perspectives within mathematics education and met all inclusion criteria. Disagreements at the full-text stage were resolved through discussion and consensus.

For transparency, the screening and selection process is summarised as follows and illustrated in [Figure 1](#). A total of 295 records were initially identified across all databases using

Table 1. Overview of Selected Included Studies

Author(s)	Context / Level	Focus of Historical Integration	Key Contribution to Review Themes
Ho (2008)	Secondary	Historical narratives in classroom instruction	Sociocultural identity dimensions and learner engagement
Panasuk and Horton (2012)	Secondary	Historical enrichment activities	Implementation constraints and curricular considerations
Goktepe & Ozdemir (2013)	Secondary	History-based interdisciplinary tasks	Interdisciplinary STEAM integration
Lim and Chapman (2015)	Secondary	History-based instructional tasks	Attitudinal development and instructional design approaches
Bütüner and Baki, (2020)	Secondary	Inquiry-oriented history-based tasks	Cognitive–conceptual development and design coherence
Kapofu and Kapofu (2020)	Secondary	Historical epistemology in classroom discourse	Cognitive–conceptual development through historical meaning-making
Agterberg et al. (2022)	Multiple educational levels	Historical perspectives in curriculum	Sociocultural identity dimensions and curriculum coherence
De Vittori et al. (2024)	Secondary	Classroom-based historical activities	Instructional design approaches supporting conceptual access
De Vittori and Arthur (2025)	Primary	Theoretical use of historical perspectives	Conceptual and epistemological framing of mathematics learning

Note. A detailed summary of methodological characteristics and quality appraisal outcomes is provided in Supplementary [Table S1](#).

the designated search keywords. Following the removal of 49 duplicate records in Mendeley, 246 unique records remained for further screening. Titles, abstracts, and keywords were then reviewed, 165 records were excluded as the study did not address the use of HOM in educational settings, or if the subject matter was unrelated to mathematics teaching, learning, or pedagogy. It resulted in 81 studies being retained for full-text assessment. After careful full-text review, 18 studies fully met all inclusion criteria and were incorporated into the final review. The remaining 63 studies were excluded for specific reasons. 28 studies were removed because they examined the HOM purely from a disciplinary or historiographical perspective, without connecting historical content to any pedagogical purpose or classroom application. 19 studies focused on curriculum documents or policy frameworks that referenced historical content only superficially, without substantive engagement with how HOM was integrated into teaching or learning. 13 studies were excluded because they presented theoretical arguments or conceptual discussions without any empirical grounding or educational context. The final 3 studies were excluded because the full text was not openly accessible.

[Table 1](#) provides an overview of all included studies, summarising their educational contexts, focus of historical integration, and key contributions to the review themes. This consolidated presentation enhances transparency and enables readers to appreciate the breadth and diversity of the included evidence base.

The relatively modest final yield reflects the specificity of the inclusion criteria, which required explicit pedagogical integration of historical perspectives within mathematics education. Many initially retrieved records focused on historical mathematics without educational application or addressed mathematics education without substantive historical integration. The multi-stage screening process enhances transparency and reproducibility and aligns with PRISMA-style systematic review principles (Page et al., [2021](#)).

2.5 Data Extraction and Analysis

Relevant data were extracted from each included study using a structured data extraction process. Extracted information included publication year, country or region, educational level, research design, and key findings or implications related to the integration of HOM in mathematics education.

The extracted data were analysed using thematic analysis, which facilitates the identification, organisation, and interpretation of recurring patterns across qualitative and mixed-methods studies (Braun & Clarke, [2006](#)). Thematic analysis was conducted through iterative reading and coding of the extracted data, followed by the grouping of codes into broader themes that captured dominant patterns across the reviewed literature.

The analysis focused on synthesising how historical perspectives have been integrated into mathematics education, the reported cognitive and sociocultural benefits, the instructional design approaches employed, the interdisciplinary connections, and the challenges encountered in classroom implementation. Extracted data were also organised into summary tables to support transparency and synthesis of findings.

2.6 Quality Appraisal

To enhance methodological transparency and address potential risk of bias in the included studies, a formal quality appraisal was conducted using the Mixed Methods Appraisal Tool (MMAT), 2018 version (Hong et al., [2018](#)). The MMAT was selected because the reviewed studies comprised diverse research designs, including qualitative case studies, quasi-experimental designs, survey-based quantitative studies, mixed-methods research, and theoretical analyses. The MMAT enables structured appraisal across multiple methodological traditions within a single review framework. The tool was selected to ensure methodological consistency in evaluating diverse research designs within a coherent appraisal structure.

Each included study was assessed against the relevant MMAT criteria according to its design classification. For empirical studies, appraisal focused on aspects such as clarity of research questions, appropriateness of methodology, adequacy of data collection procedures, coherence between data and interpretation, and transparency of analysis. For mixed-methods studies, additional criteria addressing the integration of qualitative and quantitative components were applied. Theoretical and conceptual studies were evaluated in terms of the clarity of argumentation, the coherence of the framework, and the alignment between the claims and the supporting literature.

Quality appraisal was conducted independently by two reviewers. Any discrepancies in the assessment were resolved through discussion until a consensus was reached. No study was excluded solely on the basis of quality; however, appraisal outcomes were considered during thematic synthesis to ensure that findings were interpreted in light of methodological rigor. The included studies generally demonstrated acceptable methodological alignment with their stated research designs. Most empirical studies provided clear research aims, appropriate design choices, and transparent reporting of procedures. Some limitations were noted in small-scale case studies with limited generalisability and in studies relying primarily on self-reported affective measures. These variations were taken into account during thematic synthesis to ensure cautious interpretation of findings. A summary of quality appraisal outcomes is presented in Supplementary [Table S1](#).

Table 2. Key Themes and Representative Findings

Theme	Description	Representative Findings
Cognitive–Conceptual Development	Role of history in supporting conceptual understanding	Historical narratives support reasoning, sense-making, and flexible problem-solving
Sociocultural Identity Dimensions	History as a mediational and cultural tool	Enhances inclusivity, engagement, and learner identity
Instructional Design Approaches	Pedagogical models incorporating history	Inquiry-based and constructivist designs are most effective
Interdisciplinary STEAM Integration	Links between mathematics, science, arts, and culture	Supports creativity, transfer of learning, and holistic understanding
Implementation Constraints	Barriers to classroom implementation	Time constraints, teacher preparedness, and assessment misalignment

3. Findings

The descriptive systematic review identified five major themes across the selected studies concerning the HOM integration in mathematics education. These themes reflect the reported benefits, pedagogical approaches, interdisciplinary connections, and challenges associated with historically informed mathematics instruction. To provide an overview of the synthesis, the key themes and representative findings identified across the reviewed studies are summarised in [Table 2](#).

3.1 Cognitive–Conceptual Development

The reviewed studies consistently report cognitive and conceptual benefits from integrating historical perspectives into mathematics instruction. Rather than functioning merely as contextual enrichment, historical materials are positioned as cognitive tools that support students’ conceptual development, reasoning processes, and understanding of the epistemological nature of mathematics. The synthesis of findings indicates that historical integration can promote deeper conceptual engagement when it is intentionally aligned with learning goals and instructional design (Agyei et al., [2024](#); De Vittori & Arthur, [2025](#); Fried, [2018](#)). This first theme is organised into three interrelated sub-themes, given below.

3.1.1 Conceptual Understanding and Epistemological Awareness

A central cognitive advantage highlighted in the reviewed literature is HOM’s role in fostering conceptual reconstruction and epistemological awareness. By engaging with the historical evolution of mathematical ideas from their emergence to their refinement, students move beyond viewing mathematics as a static set of rules to recognizing it as a dynamic, human-driven discipline (Fried, [2018](#)). For instance, De Vittori and Arthur ([2025](#)) identified that integrating HOM shapes primary students’ epistemological beliefs, shifting rigid “absolutist-fixist” views toward more nuanced “dynamico-cultural” perspectives that acknowledge mathematics’ evolving nature. For low-ability learners, De Vittori et al. ([2024](#)) noted that historical activities trigger epistemological reflection, helping students unpack conceptual foundations that conventional instruction may overlook.

This process also cultivates awareness of mathematical knowledge as socially constructed. When students encounter historical debates, alternative formulations, and incremental refinements, it can greatly help them appreciate that contemporary mathematical conventions are the product of collective inquiry through historical negotiation and refinement (De Vittori

& Arthur, 2025). Such insights promote reflective engagement with mathematical concepts, rather than passive acceptance of procedures.

3.1.2 Historical Reasoning and Meaning-Making

Another prominent cognitive outcome relates to students' exposure to multiple representations and solution strategies through historical materials, which enhances flexible thinking and strategic competence. Historical sources often present mathematical ideas through non-modern notations, geometric constructions, or verbal reasoning, approaches that contrast with contemporary symbolic methods (Şahin & Danaci, 2022). Engaging with these alternative representations encourages students to compare, contrast, and evaluate different methods of expressing and solving mathematical problems. Haverhals and Roscoe (2010) used Mercator's projection (a historical geometric technique) to teach the integral of the secant, exposing undergraduate students to an alternative pathway for understanding calculus that deepened their grasp of core concepts.

Across the reviewed studies, this exposure to historical alternatives correlates with improved adaptive problem-solving. Şahin and Danaci (2022) found that middle-grade students who engaged with HOM activities developed more varied computational strategies. Complementarily, Agterberg et al. (2022) emphasised that aligning historical content with increasing cognitive demand levels strengthens students' ability to evaluate method affordances and limitations. These experiences reinforce conceptual depth by prompting deliberate comparison of different mathematical approaches.

3.1.3 Conceptual Change and Sense-Making

Finally, HOM integration supports targeted conceptual change and sense-making by aligning historical conceptual struggles with contemporary student difficulties. While epistemological awareness concerns how students conceive the nature of mathematical knowledge, conceptual change focuses more directly on restructuring specific mathematical ideas and resolving entrenched misconceptions. Liu (2003) noted that HOM effectively illuminates common student misconceptions, as many modern learning challenges mirror those faced by historical mathematicians. For junior high school students, Agyei et al. (2024) found that teaching via mathematical concept histories significantly enhanced cognitive understanding. As students engage with these structured, historically rooted tasks, they can identify and resolve their misunderstandings.

Lim and Chapman (2015) further demonstrated that this alignment translates into long-term academic gains, with high school students showing sustained improvements in mathematical achievement, attributed to HOM's role in making abstract concepts meaningful. The most impactful tasks, as highlighted across studies, explicitly link historical contexts to specific conceptual goals, guiding students to reconcile their prior knowledge with targeted learning outcomes.

Overall, the synthesis confirms that HOM functions as a powerful cognitive tool, fostering conceptual clarity, epistemological awareness, and flexible reasoning. These benefits are not inherent but require intentional instructional design that embeds historical materials as integral to conceptual learning (Agterberg et al., 2022; De Vittori et al., 2024).

3.2 Sociocultural Identity Dimensions

Beyond cognitive gains, the reviewed literature underscores the profound sociocultural value of integrating HOM. The literature highlights how historical narratives and contexts can support and bridge learner identity, engagement, and inclusion. Rather than treating mathematics as a decontextualised set of rules, HOM positions it as a culturally rooted and collective human endeavor, one that reflects diverse perspectives, struggles, and innovations (Fried, [2018](#); Goktepe & Ozdemir, [2013](#)). These sociocultural dimensions complement cognitive outcomes, creating a more holistic learning experience (De Vittori & Arthur, [2025](#); Liu, [2003](#)).

3.2.1 Mathematics as a Human and Cultural Endeavour

A recurring finding in the reviewed literature is that historical perspectives help position mathematics as a human and cultural practice. Liu ([2003](#)) emphasised that integrating HOM into high school curricula reveals mathematics' humanistic core, moving beyond procedural instruction to honor the diverse traditions and contributors that have shaped the discipline. Fried ([2018](#)) further argued that linking HOM to liberal arts reorients mathematics education toward holistic human development, rejecting its reduction to a mere functional tool.

Empirical studies reinforce this perspective. For example, Goktepe and Ozdemir ([2013](#)) identified HOM as an effective interdisciplinary strategy that connects mathematics to broader or different cultural contexts. Similarly, Bütüner and Baki ([2020](#)) noted that historical active-learning activities transform students' views of mathematics from a static, abstract subject into a practical, culturally relevant tool for daily life. Taken together, these findings suggest that by repositioning mathematics within multiple cultural frames, HOM can challenge Eurocentric or one-dimensional narratives and foster recognition of mathematics as a global and inclusive discipline shaped by diverse societies.

3.2.2 Learner Identity and Values

HOM integration also plays a pivotal role in nurturing learners' mathematical identities and sense of belonging. By exposing students to historical accounts of mathematicians' struggles, collaborative discoveries, and diverse backgrounds, HOM makes participation in mathematics feel accessible and relatable, especially for students from marginalised or culturally diverse contexts (De Vittori & Arthur, [2025](#); Kapofu & Kapofu, [2020](#)). For example, Kapofu and Kapofu (2020)'s case study of Pythagoras' Theorem instruction found that HOM integration enhanced students' confidence in mathematical proofs and encouraged active participation in cooperative learning, as learners saw themselves as part of an ongoing mathematical legacy.

De Vittori and Arthur ([2025](#)) further demonstrated that tailored HOM interventions, aligned with students' existing epistemological profiles, strengthen identity formation by validating learners' perspectives while expanding their understanding of what it means to "do mathematics." Based on Ho's ([2008](#)) classroom-based evidence and Jankvist's ([2009](#)) theoretical framework, HOM can function as a pedagogical mediator that connects students' learning experiences with the historical and cultural development of mathematics through approaches such as the illumination and module methods. In doing so, students are more likely to perceive themselves as legitimate and capable participants within the disciplinary community, thereby fostering a sense of connection and belonging at the classroom level.

The literature further suggests that historical narratives support students' sense of belonging by demonstrating that mathematical knowledge has been constructed by diverse individuals and communities across time. This identity-related dimension is reported to be particularly significant in culturally diverse classrooms, where such representations can help students locate themselves within the broader mathematical community.

3.2.3 Engagement and Affective Outcomes

Historical stories, problems, and contexts are described as engaging entry points that capture student curiosity and reduce perceptions of mathematics as abstract or disconnected from human experience (Asare & Boateng, 2025). Therefore, affective outcomes, including increased interest and motivation, reduced anxiety, and positive attitudes toward mathematics, are consistently documented in empirical studies. Lim and Chapman's (2015) quasi-experimental research with 11th-grade students showed that HOM integration yielded short-term improvements in motivation and reduced math anxiety, alongside long-term gains in academic achievement, highlighting the reciprocal relationship between affective engagement and learning outcomes. Agyei et al. (2024) similarly found that Ghanaian junior high school students taught via mathematical concept histories reported higher levels of interest and motivation, as historical contexts made abstract ideas more tangible.

While Şahin and Danaci (2022) noted that some middle-grade students perceived HOM activities as time-consuming, the majority developed more positive attitudes toward mathematics, with historical tasks enriching their sense of the subject's relevance. Ho (2008) complemented these findings by identifying that HOM has a positive relationship with students' confidence in their mathematical abilities and fosters perseverance, both key affective drivers of sustained engagement. Collectively, these studies confirm that HOM's narrative and contextual richness transform mathematics from a daunting, abstract discipline into an engaging and relatable pursuit (Ho, 2008).

The reviewed studies of Theme 2 suggest that sociocultural and identity-related benefits are an important dimension of historical integration. Historical perspectives contribute to more inclusive, engaging, and humanised representations of mathematics, supporting learner identity, belonging, and affective engagement alongside cognitive outcomes.

3.3 Instructional Design Approaches

The reviewed studies indicate that the effectiveness of integrating HOM depends not simply on the inclusion of historical content, but on how that content is pedagogically structured. Across the literature, instructional design emerges as a critical mediating factor that shapes whether historical perspectives function as meaningful learning resources or remain peripheral additions (Ferreira & Rich, 2001; Fried, 2018; Jankvist, 2009). The synthesis of findings suggests that historically informed instruction is most effective when embedded within coherent pedagogical frameworks that support inquiry, conceptual development, and learner engagement (Bütüner & Baki, 2020; Fried, 2018). To capture the range of instructional design practices reported in the literature, this theme is organised into three interrelated sub-themes, given below.

3.3.1 Inquiry-Based and Constructivist Designs

A substantial body of research shows that inquiry-based and constructivist frameworks are powerful vehicles for HOM integration, positioning students as active sense-makers who

replicate elements of historical mathematical discovery. Within these approaches, historical problems and contexts serve as starting points for exploration, engaging students in conjecture, reasoning, and explanation that mirror aspects of historical mathematical development (Fried, 2018). In Kapofu and Kapofu's (2020) case study, students engaged in cooperative inquiry, tracing the theorem's historical development through cross-cultural examples to construct their own proofs. Similarly, Bütüner and Baki's (2020) action research used historical active-learning activities to shift instruction from teacher-centred to student-driven, as learners explored how historical mathematicians solved problems similar to their curricular tasks.

These designs align with Jankvist's (2009) theoretical framework, which frames HOM as a pedagogical tool to structure inquiry: by linking students' exploration to historical reasoning processes, educators maintain curricular coherence while fostering active participation. Ferreira and Rich (2001) further noted that such constructivist approaches address key barriers to HOM integration (e.g., superficial implementation) by tying historical content to specific learning objectives, ensuring it serves as a catalyst for deeper thinking rather than an add-on.

3.3.2 Narrative and Problem-Based Historical Tasks

Another prominent instructional approach involves using narrative and problem-based historical tasks. In these designs, mathematical concepts are introduced through historical stories, case studies, or original problem contexts drawn from historical sources, which can humanise mathematical content. De Vittori et al. (2024) used narratives about ancient numeral systems to design problems for low-ability students, creating a "change of scenery" that supported conceptual reflection and complemented conventional teaching. Moreover, Haverhals and Roscoe (2010) used the historical context of Mercator's projection as a problem-based entry point to teach the integral of the secant; they connected formal mathematics to a real-world historical challenge.

Problem-based historical tasks, in particular, are reported to promote epistemological awareness by exposing students to alternative solution methods and representations that differ from modern symbolic conventions (Şahin & Danacı, 2022). By engaging with historical solution strategies, students encounter multiple ways of thinking about mathematical problems, which supports flexible reasoning and critical comparison of methods (De Vittori et al., 2024). Ho (2008)'s didactical framework further informs this design by framing narratives around either a "tool" (supporting problem-solving) or a "goal" (celebrating heritage) orientation, enabling educators to tailor tasks to balance cognitive and affective outcomes.

3.3.3 Scaffolding and Sequencing of Historical Content

The reviewed literature also highlights the importance of scaffolding and sequencing in the effective integration of historical perspectives. Studies report that historical content must be carefully selected and sequenced to align with students' prior knowledge and developmental levels. When historical material is introduced without sufficient scaffolding, students may struggle to interpret archaic representations, unfamiliar terminology, or obsolete notational systems. Agterberg et al. (2022) addressed this with a structured approach: they classified historical content into four formats mapped to ascending cognitive-demand levels and provided a sequencing framework that guides teachers from basic historical context-setting to complex, higher-order thinking tasks.

Practical scaffolding strategies include adapted historical materials (e.g., simplified notation) and teacher-mediated discussions to help students bridge historical and contemporary mathematical forms. As highlighted by Jankvist (2009), the successful implementation of HOM often relies on targeted pedagogical supports to address students' difficulties with archaic mathematical representations. For cross-level implementation, Tzanakis and Thomaidis' (2011) 2×2 classification scheme serves as a scaffolding tool, helping educators select and sequence historical content that complements students' epistemological development (e.g., concrete historical examples for upper high school students).

Across studies, teachers' pedagogical decisions about scaffolding and sequencing are closely linked to their familiarity with historical content and their ability to anticipate students' difficulties. This reinforces the interconnectedness between instructional design and teacher competence, a relationship further explored in the Discussion section (Ho, 2008).

In synthesising Theme 3, the reviewed studies indicate that instructional design is a central determinant of the pedagogical value of integrating HOM. Inquiry-based frameworks, narrative and problem-based tasks, and carefully scaffolded sequencing strategies all contribute to making historical perspectives pedagogically meaningful.

3.4 Interdisciplinary STEAM Integration

In addition to subject-specific learning outcomes, the reviewed literature highlights the interdisciplinary potential of integrating historical perspectives within mathematics education (De Vittori et al., 2024; Fried, 2018; Goktepe & Ozdemir, 2013). Historical contexts are frequently used as bridges to science, technology, engineering, and the arts, supporting broader STEAM-oriented learning goals.

3.4.1 Connections Across Science, Technology, and Engineering

HOM naturally links mathematics to scientific and technological progress by revealing how mathematical ideas emerged in direct response to real-world scientific and engineering challenges. Haverhals and Roscoe (2010) exemplified this through a teaching module centred on Mercator's projection. Students were guided through the historical process by which Edward Wright performed mechanical integration to determine the vertical scaling of the projection—a problem that preceded the formal codification of calculus. This approach illuminated the reciprocal relationship between mathematical development and technological need: as one student observed, the activity demonstrated that early cartographers were “applying integration before integration was codified” (Haverhals & Roscoe, 2010, p. 349). Goktepe and Ozdemir (2013) further identified HOM as an effective interdisciplinary teaching strategy. By engaging students with Babylonian square root algorithms alongside modern calculator-based methods, the activity prompted students to compare computational procedures across historical periods, developing an appreciation of how mathematical tools evolve in response to practical demands. In addition, technology itself serves as a contemporary bridge within HOM-integrated lessons. Kapofu and Kapofu (2020) demonstrated that GeoGebra visualisation enabled students to re-examine the historical proof logic of the Pythagorean theorem through dynamic geometric construction, connecting the ancient practice of proof-making to modern digital tools.

3.4.2 Epistemological Dimensions of Interdisciplinary Integration

The above specific examples also raise questions about the epistemological relationship between mathematics and other disciplines. It is hard to deny that HOM occupies a unique position within education precisely because it reveals how mathematical knowledge is entangled with the broader history of science, philosophy, and intellectual inquiry. Rather than treating mathematics as a self-contained body of procedures, engaging with its history positions students as interpreters of a discipline that has co-evolved with astronomy, physics, and engineering across centuries. This epistemological orientation, understanding mathematics as a discipline whose development is inseparable from the scientific problems it was created to solve, is distinct from the sociocultural argument, which has been addressed in the preceding theme. The focus here is on the structural interdependence between mathematical knowledge and scientific inquiry, and on how historical integration can make that interdependence visible to students as a feature of mathematical thinking itself.

3.4.3 Real-World Applications and Authentic Contexts

Historical problems related to navigation, measurement, trade, and engineering are used as authentic modelling scenarios that require students to apply mathematical reasoning to practical situations. In Kapofu and Kapofu's (2020) study, hands-on activities such as paper cutting and splicing and GeoGebra visualisation, by embodying the historical proof logic of the Pythagorean theorem, bridged the gap from mathematical reasoning to application in specific contexts, thereby indirectly facilitating the development of modelling thinking. Meanwhile, De Vittori et al.'s (2024) study prompted students to deepen their understanding of decimal and place-value concepts by converting and applying ancient and modern numeration methods, thereby providing cognitive support for basic mathematical modelling and real-world numerical applications.

Overall, the Theme 4 review indicates that historical perspectives offer rich opportunities for interdisciplinary and STEAM-oriented learning. By connecting mathematics with science, technology, the arts, and real-world contexts, historical integration supports holistic and authentic learning experiences that extend beyond subject boundaries. It is worth acknowledging that the boundaries between this theme and the sociocultural theme are not entirely discrete. While the present theme foregrounds the structural and epistemological connections between mathematics and other disciplines, these connections inevitably carry cultural and humanistic dimensions as well. Recognising this overlap, rather than treating it as a limitation, reflects the integrative nature of HOM as a pedagogical approach.

3.5 Implementation Constraints

While the reviewed studies report multiple benefits of integrating historical perspectives, they also identify a range of challenges and constraints that can limit effective implementation. These barriers operate at the teacher, curriculum, and assessment levels, highlighting systemic factors that shape the feasibility of historical integration in practice (Agyei et al., 2024; Ferreira & Rich, 2001; Panasuk & Horton, 2012).

3.5.1 Teacher Capacity and Professional Preparation

A frequently reported challenge is teachers' inadequate specialised knowledge of HOM and limited pedagogical training in integrating historical content. Insufficient teacher knowledge of HOM is identified as a core obstacle; even educators who recognise its value

often lack the expertise to select or adapt historical materials for classroom use (Ferreira & Rich, 2001). Panasuk and Horton's (2012) survey of U.S. high school teachers further confirmed this: while most acknowledged HOM's merit, only 55% implemented it, citing gaps in both content knowledge and practical integration strategies. Critically, this knowledge deficit does not exist independently of systemic pressures. Panasuk and Horton (2012) found that teachers who felt underprepared were also significantly more likely to cite high-stakes testing as a reason for non-implementation—suggesting that inadequate training and assessment accountability operate as mutually reinforcing deterrents. When teachers lack confidence in their HOM knowledge, the additional risk of diverting instructional time away from testable content becomes an even greater disincentive. Addressing this barrier therefore requires targeted professional development that equips teachers not only with historical content knowledge, but also with strategies for embedding HOM within, rather than alongside, existing curriculum demands (Agyei et al., 2024).

3.5.2 Curriculum, Assessment, and Systemic Pressures

The systemic relationship between curriculum structure and assessment accountability constitutes perhaps the most powerful barrier to HOM integration. Tightly prescribed curricula create time scarcity, which in turn amplifies the perceived risk of incorporating any content not directly assessed. Ho (2008) documented this dynamic in the Singaporean context, where teachers reported that the demands of national examinations made them reluctant to invest time in HOM activities, fearing that any reduction in curriculum coverage would be reflected in students' examination performance. Panasuk and Horton (2012) similarly identified high-stakes testing as a primary driver of non-implementation, with teachers explicitly ranking the statement "MCAS takes priority and there is little time to supplement the curriculum" (p. 12) among their top reasons for exclusion. Liu (2003) further illuminated the structural logic underpinning this reluctance: because HOM enriches conceptual understanding and epistemological awareness rather than procedural fluency, its benefits are largely invisible to standardised assessments that prioritise the latter. This creates a perverse incentive structure in which the very outcomes HOM is best positioned to foster critical thinking, historical reasoning, and appreciation of mathematics, which are precisely those that accountability systems fail to reward. The consequence, as Ferreira and Rich (2001) observed, is that teachers come to perceive HOM as structurally incompatible with their professional obligations, rather than as a legitimate pedagogical choice.

3.5.3 Student Perceptions and Practical Feasibility

These systemic pressures are further compounded by practical constraints at the classroom level. Şahin and Danacı (2022) found that a subset of students perceived HOM activities as time-consuming and cognitively demanding, particularly when historical methods required sustained engagement with unfamiliar computational procedures. While this perception was not universal, many students reported positive attitudes, it nonetheless creates an additional layer of resistance for teachers who are already navigating packed lesson plans and accountability pressures. When students signal discomfort with the pace or complexity of historical tasks, teachers operating under curriculum and testing constraints have limited latitude to persist with approaches that may temporarily slow content coverage. This classroom-level dynamic thus feeds back into the systemic barriers described above: student

resistance, however partial, provides further justification for teachers to deprioritise HOM in favour of more immediately assessable content.

Taken together, Theme 5 synthesis revealed that the reviewed studies suggest that challenges related to teacher preparation, curriculum constraints, and assessment alignment constitute significant systemic barriers to the sustained integration of historical perspectives. Addressing any one of these barriers in isolation is therefore unlikely to produce sustained change. What is required instead is coordinated intervention across teacher education, curriculum policy, and assessment design, ensuring that the professional, structural, and evaluative conditions necessary for HOM integration are developed in concert rather than sequentially (Ho, [2008](#); Panasuk & Horton, [2012](#)).

4. Discussion

This review addressed three interrelated questions concerning the integration of HOM in mathematics education: the benefits reported in the literature, the instructional design approaches used to enact historical perspectives, and the challenges that constrain their implementation. Taken together, the findings suggest that HOM functions not merely as an enrichment resource but as a pedagogical lens that reshapes how mathematical knowledge, learning, and participation are conceptualised (Fried, [2018](#); Ho, [2008](#)). At the same time, the review makes clear that the realisation of these potentials is highly contingent on instructional design choices and systemic conditions (Agyei et al., [2024](#); Panasuk & Horton, [2012](#)).

Drawing on themes of cognitive–conceptual development and sociocultural identity, the synthesis indicates that the benefits of HOM extend beyond isolated cognitive outcomes to include epistemological awareness, identity formation, engagement, and affective dimensions. Importantly, these outcomes should not be understood as isolated effects. Rather, the synthesis suggests that conceptual development, epistemological awareness, and gains in affective and identity-related domains are mutually reinforcing (Fried, [2018](#); Ho, [2008](#)). This pattern aligns with sociocultural and constructivist perspectives on learning, in which understanding is viewed not only as an individual cognitive achievement but also as a process shaped by meaning-making, identity, and participation in disciplinary practices (Radford, [1997](#)). From this perspective, HOM supports a more expansive view of mathematics education: one in which mathematical knowledge is seen as historically and culturally situated, and learning involves both conceptual reconstruction and shifts in learners’ relationships with the discipline (Aikenhead, [2017](#); Fried, [2018](#)). This broader framing aligns with values-oriented perspectives in mathematics education, which emphasise that teaching approaches reflect and shape learners’ relationships with mathematical knowledge, identity, and cultural meaning (Abdullah & Leung, [2019](#)). The interdisciplinary connections reported in the literature further suggest that historical perspectives can serve as boundary-crossing resources, positioning mathematics within broader scientific, cultural, and societal contexts (Chorlay et al., [2022](#); De Vittori & Arthur, [2025](#)).

In relation to instructional design approaches, the review highlights that the educational benefits of HOM are not inherent in historical content itself but are mediated by how such content is designed, sequenced, and enacted in classroom practice. This emphasis on coherence resonates with prior work highlighting the importance of carefully sequenced mathematical content and aligned instructional trajectories in supporting meaningful conceptual development

(Shahrill & Prahmana, [2018](#)). Across studies, inquiry-based, constructivist, and activity-oriented approaches consistently frame students as active sense-makers who engage with historical problems, narratives, and contexts (Bütüner & Baki, [2020](#); Kapofu & Kapofu, [2020](#)). Such designs resonate with earlier theoretical arguments that historical tasks can be aligned with phases of exploration, conjecture, and explanation to support conceptual development and disciplinary ways of thinking (Fried, [2008](#), [2018](#); Radford, [1997](#)). Seen in this light, HOM integration is less about inserting historical anecdotes and more about orchestrating learning environments in which historical materials function as epistemic tools for inquiry. This underscores a key design implication: the educational value of HOM depends on coherence among learning goals, task structures, and pedagogical sequencing, rather than on the mere presence of historical references (Fried, [2018](#); Ho, [2008](#)).

Considering implementation constraints, the synthesis reveals that the feasibility of historically informed instruction is shaped by interrelated challenges related to teacher capacity, curriculum and time pressures, and assessment alignment. The reviewed studies consistently point to these challenges across multiple contexts (Agyei et al., [2024](#); Ferreira & Rich, [2001](#); Panasuk & Horton, [2012](#)). These barriers suggest that limited classroom uptake of HOM cannot be explained solely by individual teacher attitudes. Instead, it reflects a broader institutional context in which tightly prescribed curricula and high-stakes assessments prioritise coverage and procedural performance over conceptual, epistemological, or interdisciplinary learning outcomes (Panasuk & Horton, [2012](#)). When assessment systems fail to recognise the kinds of learning fostered by historically informed instruction, teachers face strong incentives to marginalise such approaches, even when they acknowledge their educational value (Panasuk & Horton, [2012](#)).

Taken together, these findings point to the need to reconceptualise HOM integration as a systemic and design-oriented endeavour. At the theoretical level, the review supports a vision of mathematics education that moves beyond a narrow focus on procedural proficiency toward a more holistic conception of learning, in which knowledge, identity, and practice are intertwined (Aikenhead, [2017](#); Fried, [2018](#)). Historically informed instruction provides a concrete means of enacting this vision by situating mathematical ideas within trajectories of human inquiry and cultural development (Ho, [2008](#)). At the pedagogical level, the evidence suggests that effective integration depends on principled instructional design: historical materials must be selected, adapted, and sequenced in ways that align with students' prior knowledge and curricular aims, rather than being treated as motivational add-ons (Fried, [2018](#); Kapofu & Kapofu, [2020](#)).

At the systemic level, the persistent challenges identified in the literature indicate that sustainable implementation will require coordinated efforts across teacher education, curriculum policy, and assessment design (Agyei et al., [2024](#); Ho, [2008](#)). Strengthening teachers' pedagogical content knowledge for HOM, creating curricular space for inquiry-oriented and context-rich approaches, and developing assessment practices that value conceptual and epistemological understanding are all necessary conditions for moving HOM from the margins to the core of mathematics instruction (Ferreira & Rich, [2001](#)).

5. Limitations of the Review

Despite the systematic approach adopted in this review, several limitations should be acknowledged. First, the review was restricted to studies published in English. While this criterion was applied to ensure consistency in analysis and interpretation, it inevitably limits the representativeness of the evidence base. Given that research on the history of mathematics is inherently international and culturally situated, excluding non-English publications may underrepresent scholarship from regions where mathematics education traditions are documented in other languages. This language restriction may therefore introduce a degree of linguistic or Eurocentric bias, particularly in a review that foregrounds the cultural and historical dimensions of mathematics.

Second, although multiple international databases were searched, some relevant regional or locally published studies may not be indexed in Scopus, Web of Science, ERIC, or Google Scholar. As a result, certain context-specific practices or innovations may not have been captured.

Third, although the included studies span educational levels from primary through tertiary, the thematic synthesis does not sufficiently foreground level-specific pedagogical distinctions. For instance, narrative-driven historical tasks may be more suitable for younger learners, whereas inquiry-oriented and source-based historical investigations may be more appropriate at secondary or higher education levels. The present review, however, focuses on cross-cutting themes and therefore offers only limited guidance on how instructional designs should be adapted to different developmental stages and institutional settings.

Fourth, while the review identifies the interdisciplinary and STEAM-related potential of HOM integration, the analysis remains limited in terms of operational detail. Although connections with science, technology, and the arts are discussed, relatively few studies provide concrete design pathways (e.g., integration with engineering design processes) or robust evaluative frameworks for assessing interdisciplinary learning outcomes. As a result, the practical applicability of these findings for classroom implementation remains constrained.

Finally, although categorising findings into thematic areas is analytically useful, it inevitably involves interpretive judgement and may obscure overlaps among the cognitive, sociocultural, and pedagogical dimensions. In addition, while the discussion highlights systemic constraints such as teacher preparation, curriculum time, and assessment alignment, it does not yet articulate a coordinated set of implementation strategies that address these factors in combination, nor does it sufficiently consider how such strategies might operate under different educational governance contexts. Taken together, these limitations suggest that the present synthesis should be interpreted as a theoretically informed mapping of trends and issues in the field rather than as a prescriptive or definitive evaluation of the impact of historical integration in mathematics education.

6. Conclusion

This descriptive systematic review synthesised research on the integration of HOM in mathematics education, focusing on reported benefits, instructional approaches, interdisciplinary connections, and implementation challenges. The findings indicate that

integrating historical perspectives into instructional design can enhance conceptual understanding, support sociocultural relevance, and foster interdisciplinary learning.

At the same time, the review reveals that effective implementation depends on alignment across curriculum structures, teacher competence, and assessment practices. Without such alignment, historical integration risks remaining superficial or marginal. The review, therefore, underscores the importance of systemic support in realising the pedagogical potential of HOM.

By consolidating existing research, this study contributes a coherent overview of how historical perspectives have been employed in mathematics education and the conditions that shape their effectiveness. The review positions HOM as a meaningful pedagogical resource that can support cognitively rich, culturally responsive, and conceptually grounded mathematics learning. Future efforts to integrate historical perspectives should be informed by both empirical evidence and sustained attention to the coherence of curriculum, pedagogy, and assessment.

Declarations

- Author Contributions : Author 1: Conceptualisation, Writing – Original Draft, Editing and Visualisation; Author 2: Writing – Review & Editing, Formal analysis, and Methodology, Validation and Supervision; Author 3: Writing – Review & Editing, Formal analysis, and Methodology, Validation and Supervision
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- AI Declaration Statement : During the preparation of this manuscript, the authors used generative artificial intelligence tools to assist with language editing, structural refinement, and clarity of expression. All scholarly content, including the study design, literature selection, thematic analysis, interpretation of findings, and conclusions, was developed and reviewed by the authors. The authors take full responsibility for the accuracy, originality, and integrity of the content of this manuscript.

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Supplementary Table S1. Full Summary of Included Studies

No	Author(s) & Year	Country/Region	Title	Educational Level	Research Design	Findings/Implications of Study
1	Ferreira and Rich (2001)	Portugal and USA	Integrating history of mathematics into the mathematics classroom	Secondary and tertiary level	Literature review and analytical synthesis	The study highlights multiple benefits of integrating HOM into teaching such as motivating students and improving teachers' practices, while identifying barriers like insufficient teacher knowledge, and provides integration methods and resources.
2	Liu (2003)	Taiwan (China)	Connecting research to teaching: Do teachers need to incorporate the history of mathematics in their teaching?	High school level	Literature Review	The study proposes five merits of integrating HOM into high school curricula: motivation, explaining student difficulties, fostering thinking, revealing humanism, guiding teaching, and finds it enriches learning but has limited impact on standardised test performance.
3	Ho (2008)	Singapore	Using history of mathematics in the teaching and learning of mathematics in Singapore	Polytechnic and junior college level	Mixed design, including a survey and action-research based case study	The study explores integrating HOM into Singapore's polytechnic/junior college math teaching, proposing a didactical framework. Findings show the approach boosts students' belief and perseverance, but is rarely used due to teacher training and time constraints.
4	Jankvist (2009)	Denmark	A categorization of the "whys" and "hows" of using history in mathematics education	Multiple educational levels	Theoretical research with literature review	The study proposes two "whys" categories (history as tool/goal) and three "hows" categories (illumination/modules/history-based), exploring their interrelations to provide a systematic framework for analysing HOM use in math education.
5	Haverhals and Roscoe (2010)	USA	The history of mathematics as a pedagogical tool: Teaching the integral of the secant via Mercator's projection	Undergraduate level	Quasi-experimental study integrated with qualitative methods	The study explores using HOM as a pedagogical tool. Findings show the module is well-received by students. It enhances motivation/understanding and addresses key unfavorable factors for integrating history into math education.
6	Tzanakis and Thomaidis (2011)	Greece	Classifying the arguments and methods to integrate history in mathematics education: An example	Upper high school level	Theoretical review, classification scheme, case study (logarithms)	The study constructs a 2×2 classification framework based on "history-as-a-tool/goal" and "history/heritage", illustrates it via logarithms, and emphasises the complementarity of the two dipoles to guide integrating HOM into upper high school mathematics education.
7	Panasuk and Horton (2012)	USA	Integrating history of mathematics into curriculum: What are the chances and constraints	High school level	Online survey, reliability analysis, & exploratory factor analysis	This study explores US high school math teachers' perceptions of integrating HOM into curriculum. Key findings include: teachers' cognition, HOM knowledge, time, high-stakes testing, and resources affect their decisions; most recognise the value of HOM but only 55% use it.
8	Goktepe and Ozdemir (2013)	Turkey	An example of using history of mathematics in classes	Junior high school level (Grade 8)	Multiple case study with mixed methodologies	This study confirms that integrating HOM into teaching enhances students' learning interest and engagement. HOM facilitates meaningful learning by reinforcing knowledge and developing skills, reveals mathematics' dynamic developmental nature, and serves as an effective interdisciplinary teaching

No	Author(s) & Year	Country/Region	Title	Educational Level	Research Design	Findings/Implications of Study
						strategy to foster positive attitudes toward mathematics.
9	Lim and Chapman (2015)	Singapore	Effects of using history as a tool to teach mathematics on students' attitudes, anxiety, motivation and achievement in grade 11 classrooms	High school level (Grade 11)	Quasi-experimental study	This study demonstrates that integrating HOM as a teaching tool positively impacts both mathematical achievement and attitudes. The research showed long-term benefits for student achievement and short-term improvements in affective domains like motivation and reduced anxiety.
10	Fried (2018)	Israel	History of mathematics, mathematics education, and the liberal arts	Multiple educational levels	Theoretical/conceptual analysis	The study explores the meaning of integrating HOM into mathematics education, opposing its mere use as a tool. It argues for linking to liberal arts to foster fully human development and rethink mathematics education's essence.
11	Bütüner and Baki (2020)	Turkey	The use of history of mathematics in the mathematics classroom: An action study	Junior high school level (Grade 8)	Action research with multiple data collection tools	The study suggests that incorporating the HOM is an effective pedagogical approach to make mathematics more engaging and meaningful for students. Using historical, active-learning activities transforms student perceptions of mathematics from a rigid, static subject to a fun, useful tool for daily life.
12	Kapofu and Kapofu (2020)	South Africa	"This Maths is better than that Maths" – Exploring learner perceptions on the integration of history of mathematics in teaching the theorem of Pythagoras: A case study	High school level (Grade 11)	Case study with qualitative data	The study explores HOM integration in teaching Pythagoras' Theorem. Findings show HOM fosters positive learner perceptions, enhancing motivation, confidence in proofs, and engagement in discovery/cooperative learning.
13	Agterberg et al. (2022)	The Netherlands	From speck to story: Relating history of mathematics to the cognitive demand level of tasks	Multiple educational levels	Theoretical framework development & case example analysis	This study provides a structured approach for incorporating HOM into mathematics education to improve both engagement and intellectual challenge. It classifies historical content into four formats, which align with increasing levels of cognitive demand to help teachers move beyond routine procedures and foster students' higher-order thinking.
14	Şahin & Danacı (2022)	Turkey	Investigating the effect of history-of-mathematics activities on middle-grade students' mental computation and opinions: An action research	Junior high school level (Grade 7)	Action research with mixed methodologies,	This study indicates that math history activities positively impact certain operations, enrich computational strategies, foster positive attitudes toward mathematics, and enable daily transfer. Though some students perceive them as complex and time-consuming.
15	Agyei et al. (2024)	Ghana	History of mathematical concepts and students' cognitive understanding of mathematics: Effect of	Junior high school level	Survey design with quantitative data analysis	The study finds that students generally have higher levels of interest, motivation, and cognitive understanding when mathematics is taught with the history of mathematical concepts as a pedagogy. It highlights the importance of incorporating the history of mathematical

No	Author(s) & Year	Country/Region	Title	Educational Level	Research Design	Findings/Implications of Study
			pedagogical content knowledge			concepts into mathematics instruction, and provides implications for curriculum reform at basic and college education levels as well as teachers' professional training to better promote students' cognitive understanding of mathematics.
16	De Vittori et al. (2024)	France	Assessing the added value of a history-based activity for students with low mathematics skills	Junior high school level based on the education system in France (Grade 6)	Empirical research along with pilot study and statistical analysis	This study shows that historical mathematics activities hold potential for low-ability students, as the observed initial gains and epistemological disorientation foster conceptual reflection, complementing conventional teaching. Such activities can serve as a "change of scenery" in curricula, leveraging ancient numeral systems to address persistent learning challenges.
17	Asare and Boateng (2025)	Ghana	The mediating effect of student motivation on enhancing student math interest through history of mathematics	Undergraduate level (First-year)	Quantitative and descriptive analysis, structured questionnaire, stratified & simple random sampling, structural equation modelling	This study shows that student motivation significantly and partially mediates the relationship between incorporating HOM and enhancing student interest in mathematics. HOM acts as a key mechanism to further enhance math interest, making it a crucial pedagogical tool to boost student engagement.
18	De Vittori and Arthur (2025)	France, Ghana, and the USA	Identifying primary school students' beliefs about mathematics and its history: The development and application of a questionnaire	Primary school level (Grade 4, 5, 6)	Questionnaire survey, k-means clustering, confirmatory factor analysis, cross-analysis with contextual variables	The study identified three distinct epistemological profiles among primary school students regarding mathematics and its history: absolutist-fixist, historico-individualistic, dynamico-cultural. The findings highlight the critical role of HOM in shaping students' epistemological beliefs about mathematics and enhancing students' engagement, motivation, and grasp of mathematical nature. The study also suggests that tailored interventions using HOM should align with students' existing profiles to maximise effectiveness, as different epistemological stances require targeted historical content and approaches to promote meaningful belief change.