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## A Meta-thematic Synthesis of Problem Posing as an Instructional Approach in Mathematics Education

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### Abstract

Problem posing has garnered increasing attention from mathematics education researchers due to its positive impact on students' learning outcomes. However, the extent of these outcomes has not been comprehensively synthesized. Therefore, this study conducted a meta-thematic synthesis to consolidate qualitative evidence on the impacts of the problem-posing approach on students' learning and their experiences during its implementation. Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework, a systematic search of literature published between 2010 and 2024 was conducted through Google Scholar. From 207 studies screened, 16 met the inclusion criteria and were analyzed through a meta-thematic synthesis. Findings revealed that the effects of problem posing on students' learning in mathematics can be categorized into cognitive and socio-emotional effects. Cognitive effects include positive changes in problem-solving, creative thinking, mathematical understanding, and argumentation skills. The socio-emotional domain includes the development of productive beliefs, positive mindsets, and affective engagement in learning. Furthermore, two overarching themes emerged regarding students' engagement with problem-posing tasks: (1) strategies for participating in problem-posing activities, and (2) perceptions of the instructional approach itself. The results affirm that the problem-posing approach contributes to holistic student development by simultaneously fostering cognitive growth and nurturing positive learning dispositions. The findings suggest that integrating the problem-posing approach in the classroom is a sound pedagogy to promote holistic student development.

**Keywords:** Effects; Meta-thematic synthesis; Problem posing; Students' experiences; Qualitative synthesis

## Abstrak

Pendekatan pemecahan masalah telah menarik perhatian yang semakin besar dari para peneliti pendidikan matematika karena dampaknya yang positif terhadap hasil belajar siswa. Namun, sejauh mana dampak tersebut belum disintesis secara komprehensif. Oleh karena itu, studi ini melakukan sintesis meta-tematik untuk mengkonsolidasikan bukti kualitatif mengenai dampak pendekatan pemecahan masalah terhadap pembelajaran siswa dan pengalaman mereka selama implementasinya. Mengikuti kerangka kerja Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), dilakukan pencarian sistematis terhadap literatur yang diterbitkan antara tahun 2010 dan 2024 melalui Google Scholar. Dari 207 studi yang disaring, 16 memenuhi kriteria inklusi dan dianalisis melalui sintesis meta-tematik. Temuan menunjukkan bahwa dampak pendekatan pemecahan masalah terhadap pembelajaran matematika siswa dapat dikategorikan menjadi dampak kognitif dan sosial-emosional. Dampak kognitif meliputi perubahan positif dalam pemecahan masalah, berpikir kreatif, pemahaman matematika, dan keterampilan berargumen. Domain sosial-emosional meliputi pengembangan keyakinan produktif, mindset positif, dan keterlibatan afektif dalam pembelajaran. Selain itu, dua tema utama muncul terkait keterlibatan siswa dalam tugas-tugas pemecahan masalah: (1) strategi untuk berpartisipasi dalam aktivitas pemecahan masalah, dan (2) persepsi terhadap pendekatan instruksional itu sendiri. Hasil penelitian menegaskan bahwa pendekatan pemecahan masalah berkontribusi pada perkembangan holistik siswa dengan sekaligus mendorong pertumbuhan kognitif dan menumbuhkan disposisi belajar yang positif. Temuan ini menyarankan bahwa mengintegrasikan pendekatan pemecahan masalah di kelas merupakan pendekatan pedagogis yang efektif untuk mempromosikan perkembangan holistik siswa.

**Kata kunci:** Dampak; Sintesis meta-tematik; Pemecahan masalah; Pengalaman siswa; Sintesis kualitatif

## Introduction

In contemporary education, problem posing has been increasingly recognized as a fundamental process that fosters conceptual understanding and mathematical proficiency. Prior research indicates that engaging students in formulating problems deepens their comprehension of mathematical structures, promotes critical reasoning, and helps bridge abstract concepts with real-world applications (e.g., Baumanns & Rott, 2022; Li et al., 2020; Sari & Surya, 2021). Encouraging students to create their own mathematical problems based on a given problem situation shifts the traditional classroom dynamic from merely solving problems to actively generating them (Cai & Hwang, 2020). Such a shift fosters a more interactive learning environment and promotes deeper cognitive involvement (Sadak et al., 2022).

Problem posing as an instructional approach is rooted in constructivist and socio-cultural theories of learning. According to constructivism, students actively construct knowledge through experiences, and problem posing is a mechanism for

deeper cognitive engagement (Papadopoulos et al., 2021; Piaget, 1952). It encourages learners to formulate problems, analyze their structures, and explore mathematical relationships, fostering higher-order thinking skills. Socio-cultural perspectives further emphasize the role of guided learning and peer collaboration in developing students' abilities to generate meaningful mathematical problems (Vygotsky, 1980; Leavy & Hourigan, 2022). These theoretical underpinnings highlight the significance of problem posing in transforming mathematics education from a mere problem-solving exercise to an interactive and creative learning process.

Empirical studies have demonstrated various cognitive and affective benefits of problem posing in mathematics education. First, it enhances problem-solving abilities by encouraging students to explore different solution strategies and problem structures (Cai et al., 2013). Second, problem posing stimulates mathematical creativity by fostering originality, flexibility, and fluency in thinking (Leikin, 2013). Third, it improves students' attitudes towards mathematics by making learning more engaging and personally meaningful (DiVriK, 2023). Additionally, problem posing has been linked to increased self-efficacy and confidence in tackling complex mathematical problems as students develop a deeper appreciation for discipline through active exploration (Kutlu & Kültür, 2021). Studies show that problem posing enhances students' mathematical skills, knowledge, and cognitive abilities (English, 2020; Zhang et al., 2024). Collectively, these benefits contribute to a more holistic and enriching mathematics learning experience (Singer et al., 2013).

Despite extensive research on the benefits of problem posing, there is still limited understanding of how it is implemented and how it affects learning in different educational settings (Polat & Özkaya, 2023). To recognize its practical value in the mathematics classrooms, educators need a clear understanding of students' and teachers' experiences during its implementation (Patac & Herrera, 2019). However, a clear gap remains in the literature regarding a study that summarizes the full potential of problem posing in mathematics, including students' experiences related to its implementation. Limited attention has been given to the qualitative aspects, particularly the experiences of students and teachers in problem-posing classrooms. Therefore, a comprehensive synthesis is needed to examine the range of outcomes and experiences associated with the use of problem posing in mathematics learning.

Most existing studies have primarily focused on the quantitative effects of problem posing, often using meta-analytical approaches to measure its impact on student learning outcomes (e.g., Calabrese et al., 2022; Kul & ÇeliK, 2020; Rosli et al.,

2014). Additionally, prior reviews, such as Han et al. (2023), have been geographically restricted, analyzing problem posing within specific educational contexts, such as Korea, thereby limiting their generalizability.

To date, no study has conducted a meta-thematic synthesis that integrates qualitative evidence on problem posing as an instructional approach in mathematics. To address the gap, this study aimed to systematically synthesize qualitative research findings on the utilization of the problem-posing approach in mathematics education. This study aimed to provide in-depth insights into the pedagogical implications of problem posing, focusing on its effects and experiential dimensions. Specifically, it addresses the following research questions:

- 1) What are the effects of using a problem-posing approach on students' mathematics learning?
- 2) How do students experience the implementation of the problem-posing approach as an instructional intervention in mathematics?

## Method

This research examined existing studies on using problem posing as an instructional approach in mathematics under a meta-thematic synthesis design. It aimed to systematically summarize the various effects of this approach on students' learning in mathematics.

### *Search Strategy*

This study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram (Moher et al., 2009) to organize the extracted data from a scholarly electronic database. Google Scholar served as the primary search engine in identifying relevant research articles. This choice was based on its wide-ranging coverage of academic literature across disciplines and publishers. Past studies have confirmed the breadth of Google Scholar's coverage (Gehanno et al., 2013; De Winter et al., 2014).

Since recent studies caution against using Google Scholar as the sole database for systematic reviews due to concerns about the indexing of materials of varying quality (Haddaway et al., 2015; Gusenbauer & Haddaway, 2020), this study applied additional screening procedures to ensure the quality of the included studies. First, only peer-reviewed journal articles were considered eligible. To do this, each article was manually verified to confirm publication in a refereed or indexed journal. Second, only studies published in the English language were included to maintain consistency in analysis. Third, following the recommendations

of Haddaway et al. (2015), the researchers screened all viewable search results up to 1,000 records to enhance transparency and coverage.

To identify relevant studies, the researchers implemented the following *search strategy*. First, the researchers used the search strings: "problem posing" OR "problem generation" OR "problem formulation" AND "Mathematics". Second, search results were refined using Google Scholar's custom date range filter from 2010 to 2024. Third, the researchers manually screened titles and abstracts to ensure relevance to problem posing and mathematics education. Fourth, once a study passes the title and abstract screening, the journal in which the study is published is reviewed to confirm its peer-reviewed publication status. In this step, non-journal items such as theses, dissertations, reports, and non-peer-reviewed conference papers were excluded. Finally, the researchers implemented the same steps up to 1,000 viewable Google Scholar records. Only studies meeting the inclusion criteria below were retained for full-text review.

### *Inclusion Criteria*

This study followed a set of inclusion criteria in determining the final sample of studies for the meta-thematic synthesis. These criteria were: (a) the study must use problem posing as an instructional intervention; (b) the study must aim to measure the effects of problem posing in mathematics; (c) the study must employ an experimental or quasi-experimental design; and (d) the study must report qualitative findings for synthesis.

Figure 1 presents the flow diagram of the study selection process. After implementing the *search strategy* described above, 219 studies were initially identified and retrieved. Duplicated records ( $n = 8$ ) and non-English publications ( $n = 4$ ) were removed, resulting in 207 studies eligible for further screening. Among these, 41 did not utilize problem posing as an instructional intervention, 22 were non-experimental studies, 82 did not measure the effects of problem posing, and 46 lacked qualitative findings. After applying the inclusion criteria, 16 studies were retained as the final sample for meta-thematic synthesis. According to Doyle (2003), the sample in qualitative meta-thematic synthesis is purposive rather than exhaustive. This suggests that the 16 studies were sufficient to generate an interpretative analysis for the objectives of this study.

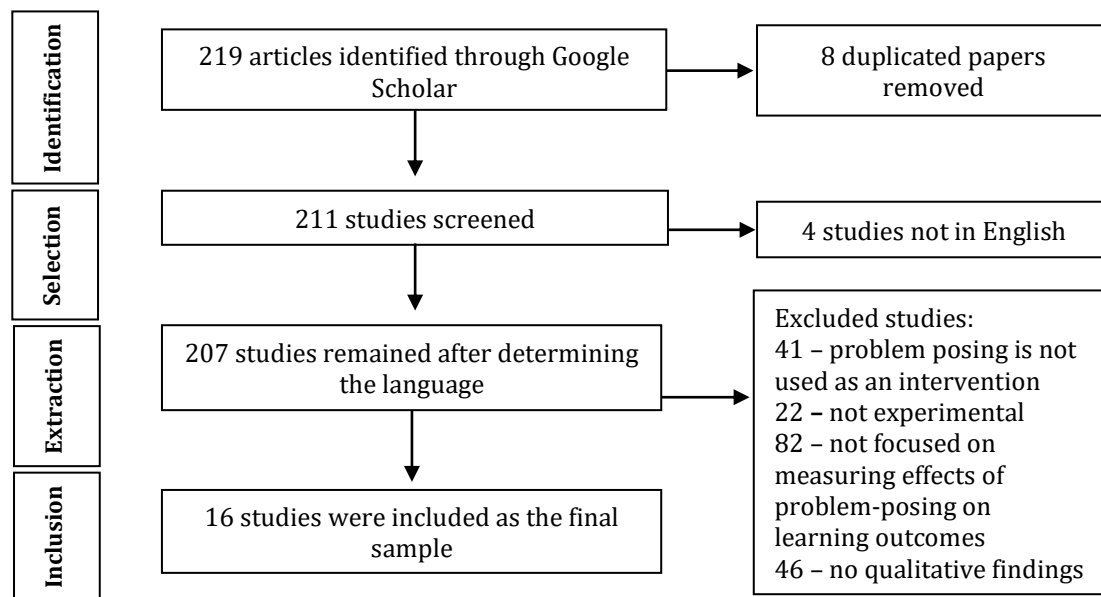


Figure 1. Flow diagram for the study sample selection process (PRISMA)

### *Reliability of Screening and Coding of Studies*

To ensure the reliability of the study selection, two researchers independently implemented the screening and coding of studies following the PRISMA flow. The researchers first performed independent title and abstract screening to identify potentially relevant studies based on the search strategy and inclusion framework. This process produced 219 articles, with a percentage agreement of 82%.

In the extraction stage, the researchers independently applied the inclusion criteria to each of the 207 remaining studies. For example, studies such as Imaoka et al. (2015) were excluded since they had no objective of measuring the effects of problem posing on student learning outcomes. Another example is Van Harpen and Presmeg (2015), which was excluded since the study did not employ an experimental or quasi-experimental design.

The screening process initially yielded 18 potential studies, with the two researchers agreeing on 12 of them. After resolving disagreements through discussion, 16 studies were retained in the final sample, resulting in 89% percent agreement. Belur et al. (2021) noted the acceptability of inter-rater percentage agreement above 80%. Table 1 presents the general information of the 16 studies included in the final synthesis.

## Data Analysis

This study employed an inductive coding technique to synthesize isolated findings from qualitative studies and qualitative findings from mixed-method studies on relevant topics. The analyses were performed using QualCoder software.

Two researchers independently coded the qualitative findings extracted from the 16 included studies. Each coder performed an in-depth review of the full texts. Each coder identified meaningful segments of the text and assigned initial codes based on recurring concepts. To increase consistency, the coders conducted a pilot coding on three studies to establish a shared understanding and interpretation of the coding framework.

The coders applied the coding scheme to the qualitative findings of all 16 studies. After implementing the coding procedure, an initial 47% percent agreement was achieved. The percent agreement was computed by adding the identical codes applied by both coders and dividing the result by the total number of codes (Cheung & Tai, 2023). According to Feng (2015), the percentage agreement can reflect the reliability of the procedure involving simple coding tasks. The coders then resolved the coding discrepancies through discussion. After several iterative discussions and revisions, the coding reached an 86% percent agreement, indicating an acceptable level of consistency in how coders interpreted and applied codes.

The codes were then clustered into categories and synthesized into broader themes following the thematic analysis approach (Clarke & Braun, 2013). This iterative and independent coding process strengthened the credibility, reliability, and confirmability of the meta-thematic synthesis.

Table 1. Information of the studies included in the meta-thematic synthesis

Code	Study Title	Author	Country	Sample
A1	Fostering mathematical creativity with problem posing activities: action research with gifted students	Ayvaz & Durmus (2021)	Turkey	six 7 <sup>th</sup> grade gifted students
A2	Developing problem posing in a mathematics classroom	Chua & Toh (2022)	Singapore	18 Secondary 3 (grade 9)
A3	Problem posing as reformulation and sense- making within problem solving	Cifarelli & Sevim (2015)	USA	two 4 <sup>th</sup> grades
A4	Problem posing based on investigation activities by university students	Da Ponte & Henriques (2013)	Portugal	36 2 <sup>nd</sup> year students
A5	Mathematical creative thinking and problem posing: an analysis of vocational high school students' problem posing	Dewi & Marsigit (2018)	Indonesia	31 vocational students, 15-17 years old

A6	Effect of teaching mathematics supported by problem-posing strategies on problem-posing skills	Divrik (2023)	Turkey	17 4 <sup>th</sup> grade students
A7	Higher-order thinking via mathematical problem posing tasks among engineering students	Ghasempour et al. (2021)	Malaysia	26 engineering students
A8	The effect of problem posing tasks used in mathematics instruction to mathematics academic achievement and attitudes toward mathematics	Guvercin & Verbovskiy (2014)	Kazakhstan	27 8 <sup>th</sup> grade students
A9	The effect of problem posing instruction on 9th grade students' mathematics academic achievement and retention	Guvercin et al. (2014)	Kazakhstan	30 9 <sup>th</sup> grade students
A10	Dissecting success stories on mathematical problem posing: A case of the Billiard Task	Koichu & Kontorovich (2013)	Israel	two math education students
A11	Appealing to Creativity through Solving and Posing Problems in Mathematics Class	Miranda & Mamede (2022)	Portugal	30 6 <sup>th</sup> grade students
A12	Cognitive Framing: A Case in Problem Posing	Pelczar et al. (2013)	Romania	one 11 until 12 years old
A13	Affective field during collaborative problem posing and problem solving: a case study	Schindler & Bakker (2020)	Sweden	four upper secondary students
A14	Problem posing and creative thinking in Mathematics class	Vieira et al. (2023)	Brazil	19 first grade students
A15	How are motivation and self-efficacy interacting in problem-solving and problem-posing?	Voica et al. (2020)	Romania	114 second year students,
A16	Examining Interactions between Problem Posing and Problem Solving with Prospective Primary Teachers: A Case of Using Fractions	Xie & Masingila (2017)	USA	10 prospective primary teachers

## Results

In this study, meta-thematic synthesis was employed to summarize the findings of the 16 included studies. The codes identified related to the effect of utilizing the problem-posing approach in Mathematics are grouped into two overarching themes: *Cognitive Effects* and *Socio-emotional Effects*. The codes identified in relation to students' experiences during the implementation of the problem-posing approach are also grouped into two themes: *Strategies in Problem Posing* and *Perception of Problem Posing*.

### *Effects of Utilizing Problem Posing in Mathematics on Students*

The effects of using problem posing as an instructional approach are categorized into Cognitive and Socio-emotional Effects. Table 2 summarizes the

codes and subthemes related to the cognitive and socio-emotional effects of problem posing on students in mathematics.

Table 2. Codes, subthemes, and themes related to effects of problem posing

Studies	Codes	Subthemes	Themes
A1, A2, A3, A4, A5, A7, A10, A11, A12, A15, A16	understanding nature of problem	Problem-solving skills	Cognitive effects
A10, A11, A16, A3, A4, A7	recognizing pattern		
A4, A10, A11, A15, A16	breaking down of problem		
A3, A4, A11, A12, A16	algorithmic thinking	Creative thinking skills	
A2, A3, A4, A5, A10, A12, A15	exploring new ideas		
A1, A5, A11, A14, A7, A8, A9	flexible thinking		
A1, A5	fluency in thinking	Mathematical understanding	
A1, A3, A11, A13, A15	ability to elaborate math ideas		
A1, A2, A8, A13, A15, A16	conceptual understanding		
A3, A4, A11	making conjecture	Argumentation skills	
A1, A10, A11, A12, A14, A15, A16, A3, A4	reasoning ability		
A2, A13, A15	enhanced self-efficacy		
A2, A8, A9, A10, A12, A13, A15	developed self-confidence	Personal beliefs	Socio-emotional effects
A1, A3, A4, A8, A9, A13, A15	increased motivation		
A8, A9, A13, A15	overcomes fear and anxiety		
A5, A8, A9, A10, A12, A13, A15	positive attitude towards math	Positive mindset	

Note: The first column indicates the studies that mentioned the generated codes.

Figure 2 presents the thematic diagram of the effects of problem posing on students in mathematics. The diagram depicts the relationship between the codes, subthemes, and themes related to the effects of problem posing.

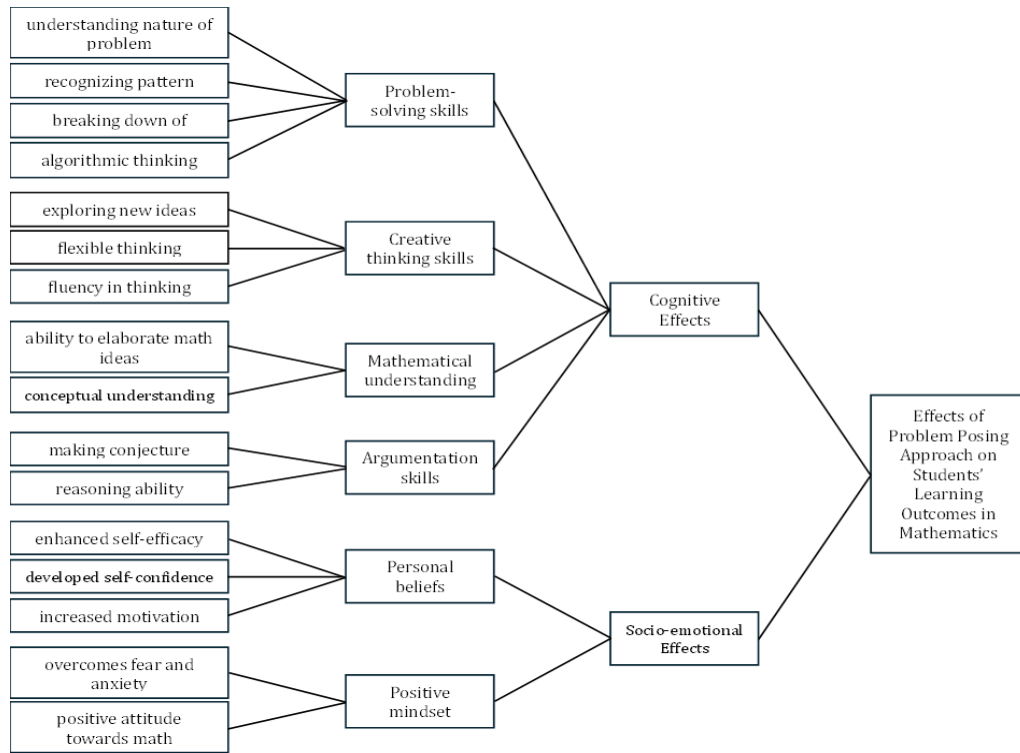


Figure 2. Thematic diagram of effects of problem-posing approach on students

### *Students' Experiences Related to the Implementation of the Problem-Posing Approach*

Students' experiences as they participate in implementing the problem-posing approach are divided into two themes: strategies for problem-posing tasks and perceptions of the problem-posing approach. Table 3 presents the generated codes and themes that encapsulate students' experiences in a problem posing-based classroom.

Table 3. Codes and themes concerning students' experience in the implementation of problem-posing approach

Studies	Codes	Themes
A1, A3, A13	inquiry learning	Strategies in problem-posing tasks
A1, A2, A4, A13	trial-and-error	
A2, A11	working backwards	
A1, A2, A4, A6, A7, A11, A15, A16	challenging	Perception on problem-posing approach
A2, A6, A8, A9, A11, A13, A15	enjoyable	
A4, A8, A9, A10, A15, A16	interesting	
A2, A3, A11, A15, A16	useful approach	

## Discussion

The subtheme *problem-solving skills* encompasses the codes *understanding the nature of the problem*, *recognizing patterns*, *breaking down problems*, and *algorithmic thinking*. These findings indicate that the primary cognitive effect of problem posing is the enhancement of students' problem-solving abilities. Across studies, it has been observed that problem posing requires students to identify the essential elements of a problem task, thereby supporting their understanding of the problem's nature (e.g., Cifarelli & Sevim, 2015; Da Ponte & Henriques, 2013; Fraillon et al., 2019). Furthermore, students engaging in problem-posing tasks tend to compare new problems with those they have previously encountered. This phenomenon reinforces the concept of pattern recognition (Andrian & Hikmawan, 2021). Another crucial cognitive activity associated with problem posing is breaking down a problem into smaller, more manageable subparts, which is fundamental for developing problem-solving skills (Dagiené et al., 2017). Additionally, problem posing encourages algorithmic thinking, meaning students practice structured, sequential, and logical approaches to problem-solving (Taylor, 2018; Doğan, 2020). These cognitive skills are closely related to computational thinking, which strongly correlates with problem-solving proficiency (Csizmadia et al., 2019).

The subtheme *creative thinking skills* encompasses the codes *exploring new ideas*, *flexible thinking*, and *fluency in thinking*. This finding suggests that problem posing encourages students to go beyond conventional approaches, promoting openness to a wide range of ideas and fostering creativity (e.g., Pelczer et al., 2013; Voica et al., 2020; Xie & Masingila, 2017). This exposure to diverse perspectives can enhance students' capacity for innovative thinking and their ability to generate novel solutions (Revenko et al., 2024). Since problem posing involves problem reformulation, students frequently generate multiple solution proposals, which characterizes the code *flexible thinking* (e.g., Guvercin & Verbovskiy, 2014; Ghasempour et al., 2021). Moreover, problem posing encourages fluency in thinking, allowing students to generate numerous potential solutions, even when minor mistakes occur. This strengthens their problem-solving confidence (Leikin, 2013). According to Kattou et al. (2013), these skills are critical indicators of creative thinking in Mathematics.

The subtheme *mathematical understanding* encompasses the codes *ability to elaborate mathematical ideas* and *conceptual understanding*. A common finding across examined studies is that problem posing enhances students' conceptual understanding of mathematical concepts (e.g., Schindler & Bakker, 2020; Voica et al., 2020). One of the observable impacts of problem posing is its ability to deepen

students' grasp of mathematical principles. Furthermore, the ability to elaborate on mathematical ideas is a prevalent code in the reviewed studies. This is likely because problem posing fosters autonomy in learning and provides a natural scaffold that allows students to make sense of their learning (e.g., Cifarelli & Sevim, 2015; Miranda & Mamede, 2022). Students' mathematical understanding is further strengthened when they are given opportunities to explain and expand upon their ideas and solutions (Kholid et al., 2021). These findings highlight the importance of integrating problem posing into instruction, as it can significantly enhance students' creative thinking and mathematical understanding.

Furthermore, the subtheme *argumentation skills* relates to the codes *making conjectures* and *reasoning ability*. These findings suggest that problem posing cultivates an environment where students freely generate conjectures related to problem tasks and develop logical reasoning to support their claims. These two cognitive activities are closely linked to mathematical proofs (Martinez, 2014). Engaging students in these reasoning-based activities enhances their ability to construct and evaluate mathematical arguments, thus strengthening their mathematical argumentation skills (Komatsu et al., 2017; Reuter, 2023).

These four subthemes collectively highlight the significant cognitive benefits of problem posing in Mathematics (Montague et al., 2014; Campbell et al., 2020; Suherman & Vidákovich, 2022). These findings emphasize the role of problem posing in improving students' learning outcomes and support its valuable contributions as an instructional approach that enhances cognitive development in Mathematics.

The subtheme *personal beliefs* relate to the codes *enhanced self-efficacy*, *developing self-confidence*, and *increased motivation*. Self-efficacy, a recurring code across several studies, highlights how problem posing fosters students' belief in their mathematical abilities. It fosters a supportive learning environment where students develop confidence in their ability to solve problems. Kim et al. (2015) noted that students with higher self-efficacy are more likely to engage in self-regulated learning, demonstrating greater autonomy in their studies. This finding aligns with the idea that problem posing promotes self-confidence (e.g., Guvercin & Verbovskiy, 2014; Vieira et al., 2023). These codes provide insight into how problem posing strengthens students' self-perception and self-concept in mathematics (Chao et al., 2019).

The subtheme *positive mindset* encompasses the codes *increased motivation*, *overcoming fear and anxiety*, and *positive attitude towards math*. Studies have consistently shown that problem posing fosters high motivation and engagement

with mathematics (e.g., Da Ponte & Henriques, 2013; Koichu & Kontorovich, 2013; Dewi & Marsigit, 2018). Additionally, research highlights that problem posing plays a role in reducing students' fear and anxiety toward mathematics by creating a more interactive and exploratory learning environment (e.g., Guvercin et al., 2014; Schindler & Bakker, 2020). These findings demonstrate that problem posing has the potential to shape a motivating and engaging learning climate that fosters enthusiasm for mathematics.

The generated subthemes *personal beliefs* and *positive mindset* illustrate the broad benefits of problem posing beyond cognitive development, highlighting its role in nurturing students' personal growth and fostering a positive attitude towards mathematics (Wang et al., 2022). By integrating problem posing into instruction, educators can create a classroom environment that enhances problem-solving and creative thinking skills, cultivates confidence, motivation, and a positive attitude toward mathematics.

The codes *inquiry learning*, *trial-and-error*, and *working backwards* characterize the strategies employed by students in engaging with problem posing-based activities. Across studies, inquiry learning emerges as the most prevalent strategy that students employ when tackling problem-posing tasks (Ayvaz & Durmuş, 2021; Cifarelli & Sevim, 2015). This strategy involves students actively questioning, exploring, and investigating mathematical concepts as they generate problems, fostering a deeper understanding of mathematical relationships and principles. As supported by Divrik et al. (2021), inquiry learning enhances problem-solving performance by encouraging students to formulate hypotheses, test ideas, and refine their understanding through iterative exploration. Such skills are highly developed in problem-posing activities.

Trial-and-error is another commonly utilized strategy in problem-posing tasks (e.g., Schindler & Bakker, 2020; Ayvaz & Durmuş, 2021). This approach is often applied when students are still identifying patterns across problems, lack familiarity with the problem structure, or have not yet fully grasped the fundamental mathematical concepts required for the problem. Through repeated attempts and adjustments, students refine their skills in posing and solving problems by testing different possibilities, discarding ineffective approaches, and discovering more efficient problem structures.

Moreover, students tend to work backwards to simplify unfamiliar and complex problems (e.g., Chua & Toh, 2022; Miranda & Mamede, 2022). This method allows students to start from a desired solution and trace back to the given conditions, helping them construct problems that align with specific mathematical

concepts. Working backwards is particularly useful when students face abstract or novel problem contexts, as it provides a structured approach to breaking down complex tasks into more manageable components.

Students' perceptions of the problem-posing approach are characterized by the codes *challenging*, *enjoyable*, *interesting*, and *useful approach*. A recurring challenge students face in problem-posing activities is dealing with open-ended tasks, which require higher-order thinking skills and self-directed learning. Many students struggle with a lack of prior experience in formulating their problems, leading to difficulties in modifying and constructing meaningful mathematical situations (Xie & Masingila, 2017; DiVriK, 2023). This finding highlights the importance of teachers' guidance and scaffolding in helping students navigate the complexities of problem posing.

Despite these challenges, students generally perceive the problem-posing approach positively. When students actively participate in generating their problems, learning becomes an enjoyable and interactive experience. The autonomy and creativity involved in problem posing allow students to explore mathematical concepts that are personally meaningful, fostering a sense of ownership and engagement (Miranda & Mamede, 2022). Creating and manipulating problems stimulates curiosity, shifting the problem-solving tasks from passive exercise into an active process.

Students also perceived problem posing as an interesting approach because it enables them to connect mathematical ideas to real-world contexts. By framing problems based on relatable situations, students develop a deeper appreciation for mathematics and its applications (Pelczer et al., 2013). The relevance and contextualization of problem-posing tasks contribute to sustained interest and motivation in mathematical learning.

Furthermore, students recognize the value of the problem-posing approach in enhancing their problem-solving abilities and mathematical thinking. By engaging in problem formulation, they develop a deeper understanding of mathematical structures, connections, and reasoning processes. These findings suggest that integrating problem posing into mathematics instruction enhances cognitive skills and nurtures a positive attitude toward learning. This move, in turn, fosters a meaningful learning experience for the students.

## Conclusion

This study synthesized qualitative findings on the effects of using problem posing as an instructional approach in mathematics education. The synthesis revealed both the cognitive and socio-emotional effects of problem posing, thereby offering a holistic picture of its pedagogical value. First, this study highlighted that problem posing fosters the development of higher-order thinking skills. Second, this study indicated that problem posing cultivates essential factors for sustained engagement and success in learning mathematics. Hence, problem posing is an appropriate approach for developing analytical skills and fostering a positive learning climate. These outcomes are relevant to the broader goals of mathematics education. This study also synthesized findings related to students' experiences when problem posing is utilized in the classroom. It highlighted that problem posing supports inquiry-based learning. This means the approach allows students to explore, experiment with, and reason through mathematical ideas. Although many perceived the approach as challenging due to its cognitive demands, this does not render it unsuitable for basic education. In fact, several studies have found that students find problem posing interesting and enjoyable, driven by the meaningful tasks it entails. This suggests that with appropriate teacher scaffolding, the approach can be effectively integrated into classroom instruction.

Moreover, this study contributes to the growing literature by integrating cognitive and socio-emotional perspectives in appraising problem-posing pedagogy. It provides theoretical insight into how the process of generating and reformulating problems can serve as both a tool for cognitive learning gains and a mechanism for advancing socio-emotional aspects. Practically, this study reaffirms the value of problem posing as a sound and holistic instructional approach for mathematics educators. It lends credence to the effectiveness of problem posing as an approach in mathematics instruction. Despite its contributions, this study has limitations. The review primarily utilized Google Scholar as its database. This choice may have restricted access to studies published in other indexed journals or databases. Future research should expand data sources to include major academic databases, such as Scopus, Web of Science, and ERIC, to ensure a comprehensive representation of the existing literature.

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