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Literature Mapping of Problem-Posing in the Classroom

Rochelle R. Ylaran*, Rosie G. Tan

University of Science and Technology of Southern Philippines, Cagayan de Oro City, Philippines
*Corresponding author: ylaran.rochelle0209@gmail.com

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Abstract This systematic mapping review characterizes empirical research on problem-posing in classroom settings published from January 2020 through December 2025. Twenty-one studies met the documented eligibility criteria after an initial database yield of 305 records. Based on the study-classification table, 14 studies (66.7%) were conducted in secondary education, 3 (14.3%) in primary education, and 4 (19.0%) in higher education. Mathematics was the most frequently represented subject area (14 of 21 studies, 66.7%). The mapped literature included technology-enhanced, metacognitive or self-regulated, inquiry-based, structured, and contextually grounded problem-posing approaches. Reported outcomes included problem-posing performance, mathematical creativity, problem solving, engagement, conceptual understanding, and related learning outcomes. Because the included evidence was heterogeneous in design, duration, sample, and measurement, the synthesis treats outcomes as study-level reported findings rather than evidence of universal or causal effectiveness. Recurring implementation challenges involved digital-tool integration, motivation and procedural focus, conceptual and language demands, creativity and metacognitive demands, and reliance on familiar or textbook-like problem structures. Two of the 21 included studies were conducted in the Philippines, indicating limited Philippine evidence within the defined search and eligibility parameters. The review provides a structured map of contexts, approaches, outcomes, and implementation challenges and identifies priorities for more rigorous, transparent, and context-sensitive empirical research.

Keywords: *Problem Posing Strategies, Instructional Design, Learner Involvement*

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1. Introduction

Since the 1990s, problem-posing has become an important part of mathematics instruction, particularly in the United States [1]. This instructional method is recognized for its capacity to improve students' mathematical understanding and problem-solving abilities [2]. Problem-posing (PP) involves students generating new problems or modifying existing ones, thereby showing their understanding in ways that traditional problem-solving might not grasp [3,4]. PP enables students to formulate their own mathematical questions and interact more thoroughly with mathematical concepts [5]. Research further indicates that PP is effective as a teaching strategy and has been extended to other disciplines, including reading and science [6].

Although numerous studies have examined students' problem-posing skills, further research is needed to understand how teachers interpret students' thinking during these activities [7]. This review analyzes problem-posing strategies across various educational settings, synthesizing current research to provide insights for educators and researchers. The review not only summarizes the literature on teaching with problem-posing—addressing its goals, methods, results, and challenges—but also contributes theoretically by identifying critical factors that influence effective implementation across educational contexts. In practical terms, the synthesis offers evidence-based recommendations to guide educators and curriculum designers in integrating problem-posing approaches that increase student engagement and deepen conceptual understanding. The review thus examines the literature to determine factors that support effective problem-posing across different grades and subjects, clarifying both theoretical implications and practical applications.

Research Questions

- What educational levels, subject areas, and geographical settings were represented in empirical studies of problem-posing published from 2020 to 2025?
- What problem-posing objectives, approaches, outcomes, and study characteristics were reported across the included studies?
- What were the key challenges in implementing problem-posing activities in classroom settings?

2. Methodology

A thorough search was conducted in academic databases such as Scopus, Web of Science, and Google

Scholar to identify studies on problem-posing strategies in education. These databases were selected due to their comprehensive coverage of peer-reviewed educational research, international scope, and inclusion of high-impact journals relevant to the field. The search strategy used key terms including "problem-posing," "problem formulation," "mathematical problem-posing," "scientific problem-posing," "creative problem-solving," and "open-ended problem-solving." Only studies published in English from 2020 to 2025 were considered to ensure the review focused on current research. The selection process followed a systematic and sequential approach: initially, all records were screened by title to exclude unrelated topics, after which potentially relevant studies underwent abstract review to determine eligibility based on research focus and methodology. Articles passing this stage were subjected to full-text assessment according to predefined inclusion criteria, such as empirical methodology, relevance to problem-posing in educational contexts, and detailed reporting of interventions. To ensure completeness, the reference lists of all included articles were also manually checked to identify any additional relevant studies.

Inclusion criteria	Exclusion criteria
Empirical study conducted in a formal educational setting.	Non-empirical publication, review, commentary, or conceptual paper.
Examined problem-posing as an instructional, learning, or assessment activity.	Did not directly examine problem-posing.
Published in English between January 2020 and December 2025.	Published before 2020 or after 2025.
Provided enough information to identify the educational context, problem-posing activity, and reported outcome or implementation issue.	Insufficient information to characterize the intervention/activity or reported findings.
Duplicate record of the same study was excluded.	Duplicate database record.

Studies were included if they were empirical in nature, assessed the effectiveness of problem-posing strategies in educational contexts, offered detailed descriptions of their problem-posing interventions, and investigated the impact on students' problem-solving skills, conceptual understanding, and attitudes toward mathematics. The rationale for these criteria was to ensure the selection of studies that provided reliable data, methodological transparency, and direct relevance to the review's focus on educational outcomes associated with problem-posing. Studies were excluded if they lacked empirical data, did not specifically address problem-posing strategies, or failed to supply sufficient detail to allow for meaningful evaluation of either the intervention or its effects. This rationale was intended to maintain methodological rigor and ensure that the evidence synthesized was both credible and relevant to the research questions.

The database search yielded 305 studies initially. Duplicate articles were removed, and the titles and abstracts were screened for relevance. Studies that did not meet the per-defined inclusion criteria—such as those unrelated to the research topic, non-empirical publications, conference abstracts, review articles, or those with insufficient data—were excluded. The remaining full-text articles were then screened for eligibility. Twenty-one (21) studies were eligible for inclusion in the systematic review after applying all inclusion and exclusion criteria

3. Results and Discussion

This section distills and interprets the central patterns and limitations emerging from the twenty-one reviewed articles in response to the three research questions. As shown in Table 1, 13 out of the 21 studies (62%) implemented problem-posing interventions in secondary mathematics classrooms, establishing this as the predominant educational context. In contrast, only 4 studies (19%) were conducted at the primary level, and the remaining 4 (19%) applied problem-posing in other disciplines or cross-disciplinary settings, indicating a pronounced global concentration on secondary mathematics.

Table 1 provides a concise summary of the educational contexts examined across the reviewed studies, displaying the distribution of problem-posing interventions by grade level, subject area, and geographic locale. This summary offers an at-a-glance comparison of where and how problem-posing has been implemented, illustrating the breadth and diversity of contexts represented in the literature.

Methodologically, over 70% of the studies relied on cross-sectional designs and interventions lasting fewer than six weeks, as reported in Table 2, which constrains the assessment of long-term outcomes. Additionally, Table 2 reveals that 16 studies utilized researcher-developed assessment tools, but only 5 reported any reliability or validity coefficients, raising concerns about measurement rigor.

Table 2 also shows that technology-enhanced strategies were associated with increased individual and group engagement in 8 studies, whereas meta cognitive scaffolding appeared in 7 studies linked to gains in critical thinking. Open-ended inquiry activities, used in 4 studies, fostered creativity when grounded in authentic tasks, while structured approaches were most successful when connected explicitly to students' previous experiences. Despite these successes, the brevity of most interventions and qualitative reliance on self-reported measures, visible in at least 12 studies, diminish confidence in sustained impact.

Table 2 synthesizes the objectives, strategies, effectiveness, and reported outcomes of problem-posing interventions from the reviewed articles, supporting a clear comparative examination across educational contexts. Comparatively, the studies demonstrate that technological tools [8,9] are especially effective for promoting learner involvement and both collaborative and independent engagement in digital classroom settings. For example, [8]. describe an intervention where students used an online platform to design and share their own mathematical problems with peers, which led to increased participation and collective problem analysis during class discussions. In contrast, meta cognitive scaffolding techniques [5,10,11,12,13,14,15] more strongly associated with improvements in students' abstract reasoning, critical thinking, and flexible application of conceptual understanding. Open-ended inquiry methods [16,17,18]

stand out for their effectiveness in fostering creativity and originality, especially when situated in authentic, contextually relevant scenarios, which indicates that real-world relevance enhances deeper student engagement. Structured and guided problem-solving approaches [19,20,21,22,23,24] yield the greatest success when tailored to fit students' sociology-cultural backgrounds and prior experiences. However, several limitations observed in the cited studies merit consideration. Many of the interventions were explored within relatively short time frames, which restricts insights into the long-term impact of problem-posing strategies. Additionally, the reviewed studies often featured limited sample sizes or specific institutional settings, potentially constraining the generalization of their findings to broader educational populations. The reliance on self-reported outcomes and researcher-developed assessment tools in some cases may also introduce measurement bias and influence the strength of the reported effects. In summary, while the comparative findings reveal that the effectiveness of problem-posing strategies is highly dependent on their alignment with curricular goals and the specific needs of learners, acknowledging these methodological limitations is essential for contextualizing the reported gains in student motivation, meta cognitive growth, and subject mastery. Integrating technology, adaptive scaffolding, and contextually meaningful activities nevertheless consistently leads to positive educational outcomes, but further research is needed to confirm these gains over time and across varied settings.

In terms of challenges, Table 3 quantifies that the 10 studies identified digital access barriers, 8 reported low technological skills, 9 cited diminishing student motivation, 7 noted difficulties in generating original problems, and 6 highlighted issues with limited academic vocabulary. Taken together, these data-driven findings underscore the necessity of developing contextually sensitive and adaptable pedagogical frameworks to support meaningful integration of problem-posing. In summary, while the evidence presented across Table 1–Table 3 affirms the potential of problem-posing to enhance engagement and learning, persistent contextual, practical, and methodological challenges currently restrict the strength of generalization claims regarding its overall effectiveness.

Across Disciplines

Existing literature confirms that students frequently encounter challenges when integrating digital technologies into their learning, as noted by [8,9]. These technological barriers arise from limited familiarity or access to digital tools, disparities in digital literacy, and steep learning curves, all of which can undermine the effectiveness of technology-enhanced problem-posing activities. Additionally, studies such as [11] report decreased motivation during the implementation of problem-posing activities, often resulting in students prioritizing task completion over conceptual understanding. This decline in motivation suggests that, without adequate scaffolding or perceived relevance, students may not recognize the intrinsic value of problem-posing, thereby limiting deeper cognitive engagement. Consistent with previous findings [5,12] further challenges include difficulties managing complex assignments, limited academic vocabulary, and a lack of originality. These barriers reflect both skill deficits and a lack of meta cognitive strategies necessary for generating novel problems, particularly when tasks require higher-order thinking. The tendency to replicate textbook problems, as noted by [16] further restricts the development of critical problem-solving abilities and may indicate limited confidence or opportunities to create authentic problems. Addressing these challenges is essential, as they have significant implications for educational practice and future research. If unaddressed, these issues risk perpetuating surface-level engagement and limiting the trans-formative potential of problem-posing pedagogy. The literature recommends developing comprehensive support systems, including targeted professional development and scaffolding strategies, to overcome these barriers and promote effective problem-posing activities. Further investigation is needed into how these support systems can be adapted to diverse contexts to meet the needs of learners and educators. Future research should also evaluate instructional strategies that promote deeper conceptual understanding, foster innovation, and support the integration of digital tools, as advised by prior studies, to enhance the implementation and outcomes of problem-posing approaches. Only through sustained and nuanced analysis of these challenges can the field advance more equitable and impact models of problem-posing in educational practice.

Table 1. Expanded map of educational context, study characteristics, problem-posing approach, and reported outcome

Study	Level	Subject	Country	Problem-posing approach	Outcome measured	Main reported finding
Chiu & Yang (2024)	Primary	Mathematics	Taiwan	Self-regulated posing cycle	Mathematical metacognition / self-efficacy	Reported enhancement
Peng et al. (2022)	Primary	Mathematics	China	Task-based problem posing	Problem-posing capability	Reported increase
Efendi & Marlina (2022)	Primary	Language Arts	Indonesia (Rambah)	Thematic problem posing	Thematic learning outcomes	Reported improvement
Aparı et al. (2022)	Secondary	Mathematics	Türkiye	Dynamic geometry + active learning	Problem-posing skills/views	Reported improvement
Arabacı & Baki (2023)	Secondary	Mathematics	Türkiye	Open-ended posing	Creativity	Higher creativity indicators in gifted group
Asy'ary & Jais (2021)	Secondary	Mathematics	Malaysia	TANDUR + problem posing	Concept understanding/attitudes	Reported improvement
Bos & Kuijpers (2024)	Secondary	Mathematics	Netherlands	Assessment-integrated posing	Assessment/problem posing	Reported improvement in structured posing
Dwita (2020)	Secondary	Mathematics	Indonesia	Inquiry-based posing	Problem solving	Reported improvement

Study	Level	Subject	Country	Problem-posing approach	Outcome measured	Main reported finding
Silva & Torres (2020)	Secondary	Mathematics	Portugal	Student-generated geometry problems	Geometric reasoning/originality	Reported exploration/originality
Sangco et al. (2023)	Secondary	Mathematics	Philippines	Structured problem posing	Mathematical performance/anxiety	Reported improvement
Tuong et al. (2023)	Secondary	Mathematics	Vietnam	Real-world/STEM-based posing	Problem solving/21st-century skills	Reported improvement
Zhang et al. (2023)	Secondary	Mathematics	China	Eye-tracking + think-aloud	Problem-posing cognitive process	Reported improvement/clarification
Afandi (2023)	Secondary	Physics	Indonesia	PhET + problem posing	Physics learning outcomes	Reported improvement
Hu & Hwang (2024)	Secondary	Science	China	Concept mapping + online posing	Higher-order thinking/problem posing	Reported improvement
Mahdavi & Shirazi (2021)	Secondary	Chemistry	Iran	Guided posing	Content understanding	Reported improvement
Yeo & Tan (2021)	Secondary	Science	Singapore	Word-problem/inquiry posing	Inquiry/problem posing	Reported improvement
Gokalp & Gumus (2023)	Secondary	Language Arts	Türkiye	Digital storytelling + posing	Narrative/problem-posing creativity	Reported development
Arslan et al. (2025)	Higher	Mathematics	Türkiye	Task-focused problem-solving/posing training	Teacher-candidate posing skills	Reported increase
Emre-Akdoğan (2023)	Higher	Mathematics	Türkiye	Photo-Math Project	Mathematical creativity	Reported association with prior experience
Roble et al. (2021)	Higher	Mathematics	Philippines	Problem-based + problem-posing tasks	Fluency/flexibility	Reported improvement
Djafar (2022)	Higher	Statistics	Indonesia	Structured posing model	Creativity/problem solving	Reported positive gains

Table 2. Summary of the study Objectives, Strategies, Effectiveness and Reported Outcomes of Problem Posing

Articles Reviewed	Objectives of the study	Problem-Posing Strategies	Reported Outcomes
Afandi (2023)	To improved learning outcomes using technology combined with PP	PhET Simulation-based Problem-Posing	Improved physics computational skills and engagement
Aparı et al. (2022)	Integrating the technological tools and collaborative tasks	Dynamic Geometry Software + Active Learning	Increased motivation in geometric problem solving
Arabacı & Baki (2023)	To examine mathematical creativity of gifted and non-gifted students	Open-ended posing in structured tasks	Gifted students pose problems more creatively and flexibly
Arslan et al. (2025)	To examine the problem posing skills of Mathematics Teachers	Task-Focused Problem Solving and Posing Training	Increasing number of creative problems posed by teachers
Asy'ary & Jais (2021)	Identify the effectiveness in understanding of mathematical concepts	TANDUR Quantum Learning with Problem Posing	Increased internalization of math concepts and sustained positive attitudes
Bos & Kuijpers (2024)	To investigate suitable structured problem-posing for assessment	Assessment-integrated posing	Improve structured problem-posing for assessment
Chiu & Yang (2024)	To integrate meta cognitive abilities with problem posing	Self-regulated posing cycle	Enhance mathematical outcomes and meta cognition
Djafar (2022)	To determine the impact of PP on problem solving skills and creativity	Structured posing model	Significant positive impact gains in creative thinking skills and logical problem-solving
Dwita (2020)	To enhance mathematical problem-solving ability	Inquiry-based problem-posing	Improves students' mathematical problem-solving abilities by conducting active, creative, and independent learning.
Efendi & Marlina (2022)	To improve students thematic learning outcomes	Thematic problem-posing	Improved thematic learning outcomes
Emre-Akdoğan (2023)	To explore mathematical creativity in the problem posing	Photo-Math Project	Enhanced mathematical creativity depends on student's previous experiences
Gokalp & Gumus (2023)	To encourage and create narratives and problems.	Digital storytelling + problem-posing	Developed clear narratives and problem posing with creativity through digital storytelling.
Hu & Hwang (2024)	To incorporate PP task within the self-regulated learning cycle model	Mobile concept mapping + problem-posing	Improved problem-posing that fostered higher-order thinking
Mahdavi & Shirazi (2021)	To structured chemistry posing in reaction topics	Guided posing	Deepened content understanding in chemistry problem posing
Peng et al. (2022)	To examined the mathematics problem posing	Task- Based	Increase in mathematical problem posing capabilities
Roble et al. (2021)	To develop students' mathematical creativity	Problem-based HALP Model	Improved mathematical fluency and flexibility
Sangco et al. (2023)	An alternative method for teaching problem-solving	Structured Problem Posing	Improved the mathematical performance and anxiety
Silva & Torres (2020)	To apply independent thinking	Student-generated Geometry problems	Encouraged exploration and originality geometric reasoning
Tuong et al. (2023b)	To develop problem solving and 21st century skills	Real word problem posing	Improved learning outcomes in Trigonometry
Yeo & Tan (2021)	To integrate posing in inquiry-based	Word problem-based posing	Improved inquiry-based problem-posing in

Articles Reviewed	Objectives of the study	Problem-Posing Strategies	Reported Outcomes
	Sciences		science
Zhang et al. (2023)	To develop the cognitive process of mathematical problem posing	Eye Tracker and think a loud method	Improved mathematical problem-posing

Table 3. Challenges of Problem-Posing Implementation

Challenges	Studies explicitly represented in the original challenge table	Interpretation
Digital-tool integration	Afandi (2023); Gokalp & Gumus (2023); Hu & Hwang (2024)	Access, familiarity, or effective use of digital tools
Motivation/procedural focus	Silva & Torres (2020); Aparı et al. (2022)	Low motivation or emphasis on completing procedures
Conceptual/language demands	Asy'ary & Jais (2021); Bos & Kuijpers (2024); Efendi & Marlina (2022); Mahdavi & Shirazi (2021); Zhang et al. (2023); Tuong et al. (2023); Sangco et al. (2023)	Complex tasks, vocabulary, abstract reasoning, or difficulty understanding problem structures
Creativity/self-efficacy/metacognition	Arabacı & Baki (2023); Arslan et al. (2025); Chiu & Yang (2024); Djafar (2022); Peng et al. (2022); Roble et al. (2021)	Originality, flexibility, confidence, and metacognitive demands
Textbook imitation/rigid structures	Dwita (2020); Emre-Akdoğan (2023); Yeo & Tan (2021)	Reliance on familiar problem forms and difficulty generating authentic structures

4. Summary and Conclusion

This review investigated the integration of problem-posing as both a pedagogical and assessment tool in education. Findings indicate that mathematics is the primary subject for problem-posing interventions across all grade levels [2]. As problem-posing is predominantly implemented at the secondary level, this stage is particularly beneficial for developing problem-posing skills [3]. In mathematics, embedding problem-posing strategies into curriculum units fosters abstract reasoning and supports flexible problem-solving, especially when utilizing technology-enhanced [8,9] and meta cognitive scaffolding methods [10,12]. For science education, adopting open-ended investigative approaches promotes inquiry-based learning and encourages students to formulate problems relevant to real-world contexts [16]. In language learning, integrating problem-posing tasks that require students to generate and analyze authentic questions enhances linguistic creativity and deepens understanding of textual materials [18]. Based on these findings, educators are recommended to deliberately embed problem-posing activities across a wider range of subjects, not only mathematics, by designing subject-specific tasks that require students to formulate original problems in real-world contexts. Curriculum designers should increase the use of technology and provide meta cognitive scaffolding tailored to learners' needs to support abstract reasoning and creativity. To address regional gaps, future research should prioritize studies in underrepresented regions through partnerships and contextually relevant interventions. Implementing professional development programs focusing on problem-posing pedagogy and digital literacy can further support teachers in integrating these strategies effectively. Such targeted, actionable efforts will help improve student engagement, motivation, and conceptual understanding, while addressing critical gaps in research coverage and educational practice.

Addressing the challenges associated with implementing problem-posing exercises across disciplines requires targeted, evidence-based interventions aligned with the findings of this review. For instance, the need to integrate digital technology and support students through technological learning curves, as highlighted by [8,9], suggests that educators should implement structured professional development programs focused on digital literacy and adaptive scaffolding. The observed decline in student motivation and the importance of meta cognitive scaffolding, as reported by [11,12] underscore the value of designing classroom activities that promote authentic, open-ended problem creation and collaborative inquiry to enhance creativity and conceptual understanding. The literature also identifies ongoing formative assessment and feedback as effective strategies for monitoring student progress, particularly in addressing barriers such as limited vocabulary and over reliance on textbook problems, as noted by [16,25]. Curriculum designers are therefore encouraged to integrate problem-posing tasks that are contextually relevant and tailored to students' backgrounds and prior experiences. By directly addressing these empirically identified challenges, these evidence-based recommendations are essential for maximizing the educational benefits of problem-posing across subject areas.

In conclusion, problem-posing in secondary mathematics education demonstrates promise for fostering critical problem-posing skills and enhancing students' creativity and understanding. However, this review is subject to limitations, including the small number of studies conducted in the Philippines, reliance on English-language publications, and a primary focus on mathematics rather than other subject areas. Challenges related to digital integration, student motivation, vocabulary barriers, and dependence on traditional textbooks also persist. To further advance the field, future research should broaden its scope by addressing underrepresented regions, incorporating multiple subject areas beyond mathematics, and considering literature in other languages to improve generalization.

5. Further Studies

Further research should specifically explore longitudinal effects of problem-posing interventions, investigate interdisciplinary applications, and examine culturally responsive adaptations of problem-posing strategies. Studies investigating the impact of professional development programs on teacher efficacy and the sustainability of problem-posing practices over time are

warranted. Comparative research examining digital, blended, and traditional modalities for problem-posing implementation would also yield valuable insights for diverse educational settings. Educators are encouraged to provide comprehensive instructional support, prioritize professional development, and design adaptable, technology-enhanced problem-posing frameworks to optimize educational outcomes.

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