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A Comparative Study of Problem-Posing Implementation Between Indonesia and Abroad in Mathematics Education

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ABSTRACT

The application of problem posing in mathematics education faces challenges, including teacher misconceptions and difficulties. This study examines the implementation of problem posing in Indonesia and internationally, focusing on the improvements achieved and the steps taken to achieve them. A Systematic Literature Review (SLR) method with a qualitative descriptive approach was used, adhering to PRISMA guidelines, to explore the impact of problem posing on cognitive and affective aspects. Cognitive aspects include creativity, problem-solving skills, critical thinking, mathematical communication, and related skills, while affective aspects include motivation, curiosity, and enjoyment. The research found that the general structure of problem posing is similar across countries: the teacher presents a situation, students pose a problem, and then solve it. However, international practices often include additional steps, such as identifying problem elements and designing problem structures, before formulation. Indonesia's approach tends to focus more on textbook-based activities and exercises. This study highlights the differences and similarities in problem-posing methods, suggesting that while there are shared principles, international practices often incorporate a more structured and comprehensive approach than those in Indonesia.

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1. INTRODUCTION

Mathematics is one of the important disciplines in education worldwide, especially in problem-solving and logical thinking. One approach that can improve understanding of mathematical concepts is problem-posing, which is a learning process carried out by students who not only solve problems, but also compose, modify, or reformulate mathematical problems [1], [2]. Problem-posing is one of the approaches to mathematics education that has received increasing attention in the world of education [3], [1]. Research on problem-posing has been applied in several countries, such as Australia [4], Spain [5], Turkey [6], Taiwan [7], Germany [8], Thailand [9], Ireland [10], Hungary [11], and Romania [11].

Problem posing is the process of formulating mathematical problems derived from a given context, information, or situation, where the problem is developed through modification in accordance with given conditions [3], [12]. From this perspective, problem-posing serves as a powerful pedagogical tool that compels students to engage deeply with mathematical concepts, fostering a robust understanding through the act of creation. In this context, problem-solving is inherently linked to problem-posing: while problem-posing involves formulating mathematical problems, problem-solving is the subsequent process of devising and executing strategies to arrive at a solution. Both processes are symbiotic, with the ability to pose a problem often enhancing one's capacity to solve it effectively, and vice versa [13]. This practice is grounded in the theoretical premise that active construction of knowledge is paramount for meaningful learning, aligning with constructivist learning theories.

Implementing problem posing is one of the most important aspects of education, as it can foster international collaboration in raising educational standards, particularly in mathematics. Through the exchange of best practices, ideas, and knowledge from various educational contexts and systems, researchers and educators can gain a deeper understanding of the effective strategies and challenges involved in this approach.

Numerous studies have investigated the use of problem-posing in other countries to enhance various aspects and have identified strategies that can be used. Research in various countries has shown that problem-posing can improve logical reasoning, creativity in mathematical modelling, learning motivation, learning achievement, problem-solving, and posing performance, and positive attitudes toward mathematics [13], [14], [8], [15], [6], [16], [17]. Furthermore, the literature review, which compiles findings from numerous studies, highlights the trends in aspects that can be improved through the implementation of problem-posing in mathematics learning. Kull et al. [18], through a meta-analysis, found that the problem-posing strategy can significantly improve mathematics learning achievement, problem-solving skills, problem-posing skills, and attitudes toward mathematics. Another systematic study by Kaur and Rosli [19], using a Systematic Literature Review (SLR) approach, concluded that problem posing has a positive impact on learning achievement, critical thinking, creative thinking, and learning motivation. Meanwhile, Aktas [20], in a bibliometric study, revealed that problem posing contributes to the improvement of problem-posing and problem-solving skills, learning outcomes, attitudes toward mathematics, and conceptual understanding among prospective teachers. However, further studies are needed to extend previous work by identifying additional benefits of problem posing that have not been described.

Although its benefits have been recognized, implementing problem posing in classroom learning practices still faces various challenges. There are difficulties that prospective mathematics teachers face in problem-posing activities, such as creating problems related to students' daily lives [21]. Rochaminah [22] found that teachers rarely give problem-posing tasks to students, and many of them misinterpret problem-posing in mathematics learning. Therefore, many studies are needed to discuss how problem posing is implemented in the classroom. According to Baumanns and Rott [23], the process of problem posing involves several key stages: (1) choosing a starting point; (2) listing attributes or registering properties; (3) applying the "What-If-Not" strategy by posing the question "what if not?"; (4) asking questions or generating problems; and (5) analyzing the problem. After this analytical stage, students are expected to proceed with solving the problem. Baumanns and Rott [23] have proposed a phase model of problem posing that includes situation analysis, variation, generation, problem-solving, and evaluation. Nevertheless, it cannot be denied that slightly different or even additional phases of the model may emerge.

This study has two main points to discuss: the benefits derived from problem posing (i.e., the aspects that can be improved through its implementation) and its procedural steps. Although these two points have been discussed frequently, further studies are needed to examine how far the benefits of problem posing and the steps in problem posing have advanced across various researchers' perspectives. Additionally, this study will compare these two aspects among researchers in Indonesia and abroad. The lack of comparative analysis between national and international research highlights the importance of this study. By bridging this gap, the benefits and procedural steps of problem posing, which are often developed outside Indonesia, can be critically examined and contextualized within the Indonesian educational landscape. Furthermore, this study may serve as a model for researchers in other countries to conduct comparative analyses of their national practices and international developments in problem-posing implementation.

Through a comprehensive literature review, it is hoped that insights will be gained to improve the quality of mathematics education. The specifics of the Research Questions (RQ) to assist in obtaining pertinent data, such as: (1) What aspects can be improved in mathematics learning through the application of problem posing? (2) How is the application of problem posing in mathematics learning in Indonesia and abroad in terms of aspects that can be improved? Furthermore, (3) How is the application of problem posing in mathematics learning in Indonesia and abroad in terms of the steps of problem posing?

2. METHOD

2.1 Research Design

This study used a Systematic Literature Review (SLR) with a qualitative descriptive approach to examine the application of problem posing in mathematics learning, both in Indonesia and internationally. According to Higgins [24], conducting an SLR is essential, as it clarifies research priorities, informs the development of a conceptual framework for future investigations, and deepens one’s understanding of authoritative decisions within the field. Furthermore, the SLR approach sharpens the information gathered by systematically filtering, organizing, and synthesizing relevant research findings.

2.2 Population and Sampling

The sample in this study consists of 21 articles published between 2020 and 2024 in the field of mathematics education. These articles were selected from reputable databases, including Scopus, ERIC, and ScienceDirect. The search was conducted using the keywords: ("Problem-Posing" OR "Problem Posing") AND ("Mathematics" OR "Math" OR "Mathematical"). The selection process aimed to capture recent and relevant studies that discuss the application of problem posing in mathematics learning.

2.3 Data Collection Tools

The systematic literature review procedure in this study adapts the data selection stages from [25] and [26], following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework.

2.4 Data Collection

The stages of the review process include the following steps:

1. Data Selection, this stage involves:
   1) Formulating research questions and identifying relevant articles;
   2) Determining inclusion criteria (Table 1); and
   3) Filtering articles from various databases, namely Scopus, ERIC, and ScienceDirect.

   Articles were reduced according to predefined criteria. A total of 21 articles were selected for in-depth analysis through abstract review and full-text reading.
2. The coding instrument used was adapted from the Paper Classification Form (PCF) developed by Kizilaslan et al. [27], which meets the requirements for validity and reliability. The indicators analyzed in the PCF include the article title, author(s), author's country, journal name, year of publication, journal type, language, indexing status, main discipline, research method, data collection technique, sample, and data analysis approach. In addition, the researchers created a data matrix comprising research objectives, integrated learning models, themes, and key findings. The data collected were analyzed using percentage calculations.
3. This stage focuses on identifying key patterns in the articles, including major findings, forms of problem-posing integration, and aspects of mathematics learning that can be further developed.
4. Finally, the identified patterns were synthesized to answer the formulated research questions (Figure 1).

2.5 Data Analysis

In this step, we calculated the percentage distribution of each finding and investigated the underlying causes by referring to relevant supporting research (Table 1).

Table 1. Inclusion and Exclusion Criteria

No	Inclusion Criteria	Exclusion criteria
1	Published Year: 2020 – 2024	Published year < 2020
2	Includes research articles	Includes article review
3	Indexed in Scopus, ERIC, ScienceDirect	Not indexed in Scopus, Eric, ScienceDirect
4	Contains aspects that are improved with problem posing OR problem posing steps	Does not contain aspects that are enhanced by problem posing OR problem posing steps
5	Problem posing as a model/approach (not as an aspect)	Problem posing as an improved aspect

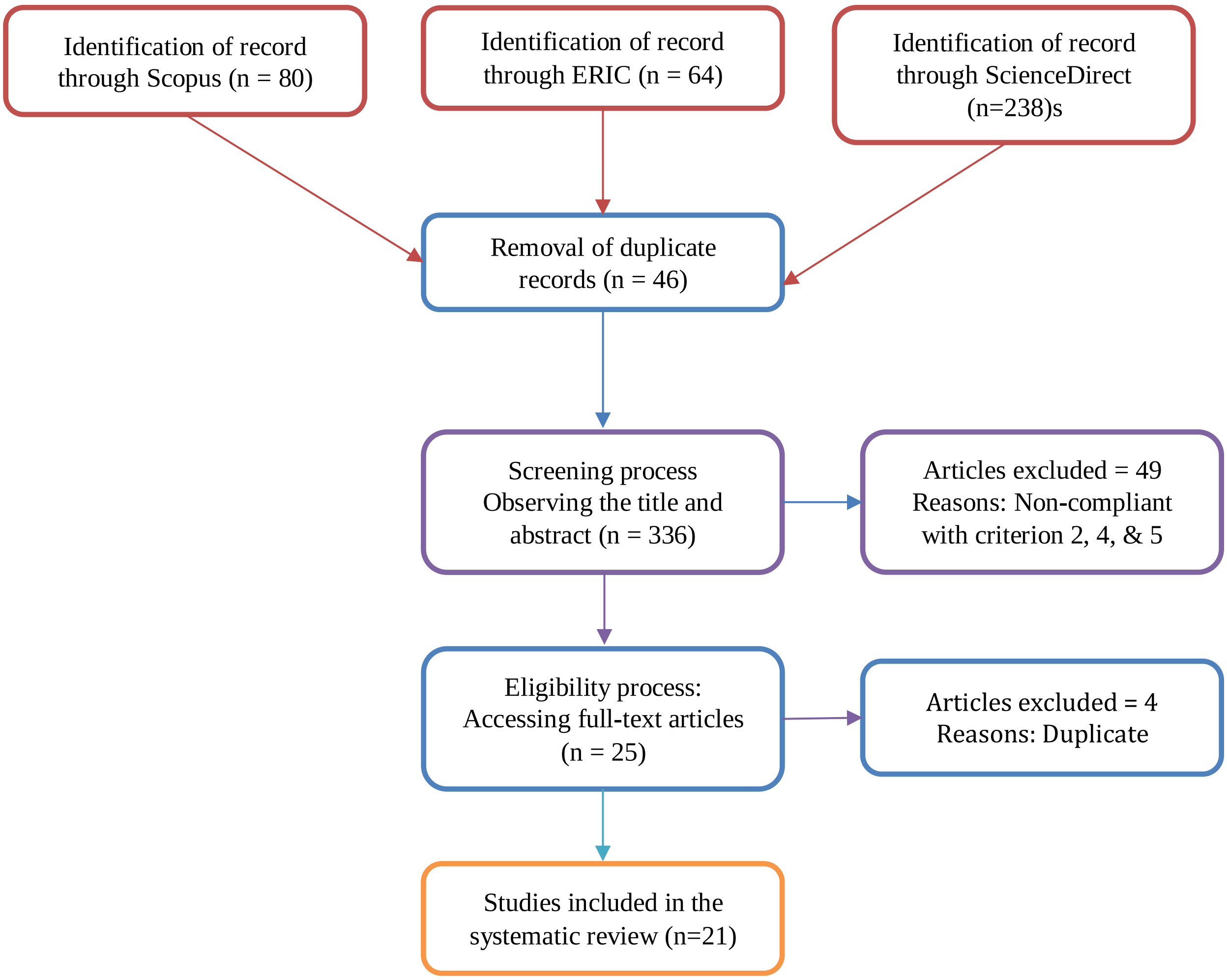

Figure 1. Flowchart of the article selection procedure

3. RESULTS AND DISCUSSION

3.1 Results

This systematic literature review examines articles published between 2020 and 2024. The review includes international articles indexed in Scopus, ERIC, and Science Direct that focus on the implementation of problem posing in mathematics education. The distribution of articles identifying the country of origin of the research conducted is shown in Figure 2.

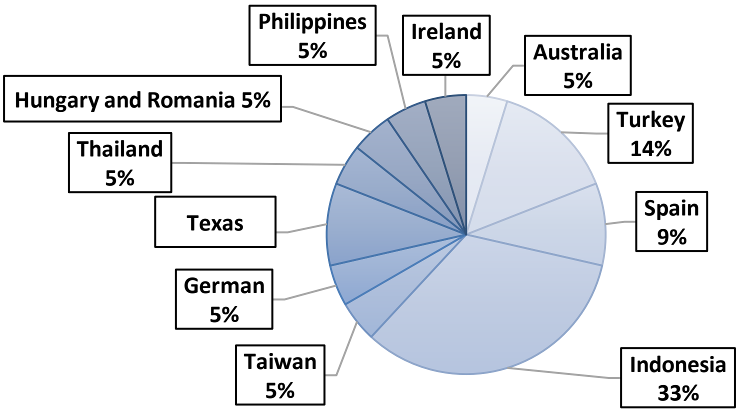

Figure 2. Distribution of Articles by Country of Study

The article review was conducted by dividing the research objectives' focus into the effects of applying problem posing on cognitive and affective aspects, as shown in Figures 3 and 4. The cognitive aspects include creativity, problem-solving performance, problem-posing performance, critical thinking, learning achievement, mathematical thinking, modelling performance, pedagogical content knowledge, written mathematical communication skills, and adaptive reasoning. Affective aspects influenced by problem posing include Interest, Value, Enjoyment, Boredom, Acceptance, Motivation, Curiosity, Hard Work, and Responsibility.

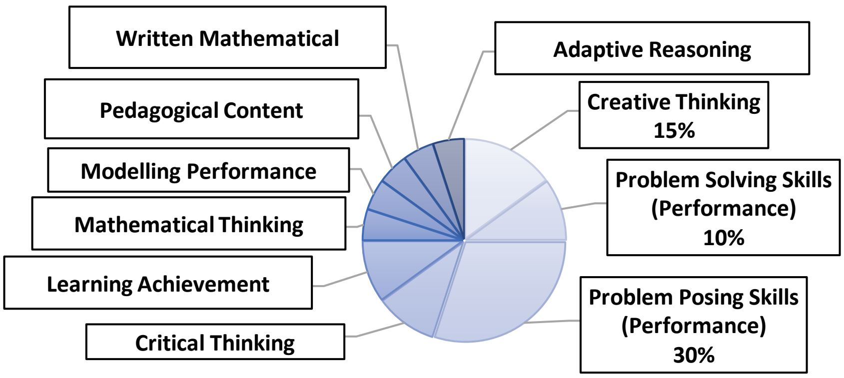

Figure 3. Distribution of Articles by Enhanced Cognitive Aspects

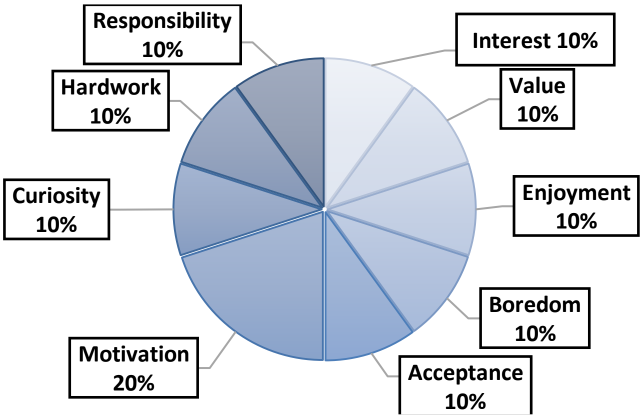

Figure 4. Distribution of Articles by Enhanced Affective Aspects

A review of articles highlighting improvements in problem posing, both in Indonesia and abroad, is presented in Tables 2 and 3.

Table 2. Enhanced Aspects through the Implementation of Problem Posing in Indonesia

Enhanced Aspects	**Researcher**
Creativity	[28], [29]
Mathematical Thinking	[30]
Critical thinking	[28] [31]
Curiosity	[29]
Hard work	[29]
Responsibility	[29]
Motivation	[17]
Adaptive reasoning	[32]
Written Mathematical Communication Skills	[33]

Table 3. Enhanced Aspects through the Implementation of Problem Posing Abroad

Enhanced	**Country**	**Researcher**
Creativity	Australia	[4]
Problem-solving skills (performance)	Turkey, Hungary, Romania, Ireland	[6], [11]
Problem posing skills (performance)	Turkey, Hungary, and Romania	[6], [11], [34], [35], [10], [36]
Learning achievement	Taiwan	[7], [9]
Interest	Spain	[37]
Value	Spain	[37]
Enjoyment	Spain	[37]
Motivation	Taiwan	[7]
Acceptance	Taiwan	[7]
Boredom	Spain	[37]
Modelling Performance	German	[8]
Pedagogical content knowledge	Texas	[38]

Furthermore, the review of articles was carried out according to the steps of problem posing in learning, as briefly shown in Tables 4 and 5.

Table 4. Problem Posing Steps in Indonesia

Problem Posing's Steps	Researcher
Situation Orientation, Creating Problems, Solving Problems, Class Discussion, and Practice	[28]
Follow the information closely from the teacher, read/review information in the student book, Formulate the problem or question based on the information obtained, Formulate and solve problems in LKPD (Student's worksheet), Discuss/ask friends or teachers, Conclude the subject matter based on teacher guidance, and Pay attention to the feedback given by the teacher.	[29]
Informing learning goals, Group formation, Presenting Problems, Posing problems, Solving the problems	[17]

Table 5. Problem Posing's Steps Abroad

Problem Posing's Steps	Country	Researcher
The students pose a problem. The posed problem is solved, and the data are then changed so that the students can pose a different problem.	Turkiye	[6]
Understanding the Situation, Identifying Problem Elements, Designing the Problem, Articulating the Problem, Checking the Problem	Spain	[5]
Problem Construction, Problem Solving, Peer Assessment, Group-Achievement Visualization	Taiwan	[7]
Students are given real-world situations; Students are asked to formulate mathematical problems based on those situations; Students are asked to solve the problems they created.	German	[8]
Modeling, practice, problem posing, problem solving	Hungary and Romania	[11]
Grouping the students provides information, situations, charts, and pictures, and encourages students to use mathematical knowledge. The teacher asks each group to exchange problems; students present their problems and the problems they receive, and students upload their assignments.	Thailand	[9]
Analyze the mathematical problem, use problem hints to create problems, Formulate problems, then Reflection and consolidation.	Ireland	[10]

3.2 Discussion

3.2.1 Aspects That Can Be Improved in Mathematics Learning Through the Implementation of Problem Posing

This study found several articles that explain aspects that can be improved through the implementation of problem posing. The articles are divided into several kinds, including quantitative-experimental research, qualitative research, R&D, and action research. In quantitative research, eight articles (38,09%) of them are experimental research which shows that problem posing activity can effectively improve learning achievement (Utami & Hwang, 2024; Sangpom & Sangpom, 2024), critical thinking [28], [31], creative thinking [28], Written Communication skills [33], adaptive reasoning [32], and motivation [17]. Experimental research allows researchers to control variables, enabling them to accurately identify the influence of strategies or activities related to problem posing. Two articles in this study (0,09%) used a mixed-methods design that included an experimental design, in which it was found that problem posing can improve problem posing skills [34] and pedagogical content knowledge [38]. Other findings in this study include nine qualitative research articles (42, 85%), one research and development (R&D) article, and one action research article, which produced various findings. These findings strengthen the results of quantitative-experimental and mixed-method research and generate new hypotheses that can be further explored or tested through a quantitative-experimental approach.

The implementation of problem posing in mathematics learning has been proven to increase students' learning achievement [7], [9]. The increase in learning achievement is supported by constructivist theory, which emphasizes students' active engagement in the learning process. In this context, problem posing enables students to construct problems actively, thereby making the knowledge gained more meaningful and in-depth. In addition, the contribution of problem posing to learning achievement is supported by Kurniasih et al. [30], who found that how teachers stimulate learning through problem posing (as well as Poetry and Singing) can improve mathematical thinking skills. This skill is an important component in supporting students' learning achievement.

Regarding the improvement in student achievement through the implementation of problem posing, this study highlights the importance of integrating technology into problem-solving activities, as demonstrated in [7]. Furthermore, as demonstrated in [9], problem posing can also be applied in online learning, not just in offline learning. This suggests that implementing problem posing will be more effective when supported by technology and combined with a problem-solving approach. Furthermore, problem posing can be an effective alternative in online learning contexts, especially when face-to-face learning is not possible, such as during the COVID-19 pandemic.

In addition to influencing overall mathematics learning achievement, the findings in this study also indicate that problem-solving activities can improve students' critical and creative thinking skills [28], [31]. These studies revealed that problem posing is more effective in enhancing students' critical and creative thinking than expository and conventional learning. This supports [39] argument that problem posing is a way to make students become critical thinkers. According to [28], problem posing plays a very important role in improving students' creative and critical thinking, as does the use of the contextual learning model. Their findings reveal that, from a critical thinking perspective, contextual learning has a greater influence than problem posing. Conversely, when viewed from the perspective of creative thinking, problem posing has a greater influence than contextual learning. However, in general, both critical thinking and creative thinking can be improved through both problem posing and contextual learning. This highlights the importance of applying problem posing in mathematics learning, as well as the importance of contextual learning in improving students' critical thinking and creative thinking skills. Another finding in [31] reveals that the implementation of problem posing can improve students' critical thinking skills, as can the application of problem-based learning. This finding shows the difference in critical thinking skills when using problem posing and problem-based learning compared to conventional learning. These findings reveal that, in addition to having the same role as contextual learning in improving critical thinking, problem posing also has the same role as problem-based learning in improving students' critical thinking skills. Thus, it can be understood that problem posing is as effective as contextual learning and problem-based learning in improving students' critical and creative thinking skills. Regarding creative thinking, the qualitative research conducted by [4] also supports the above findings, namely that problem-posing activities support students' creative thinking skills. Additionally, the research emphasizes the aesthetic aspects of mathematics, such as figural quadratic patterns, which can capture students' attention and enhance their engagement in learning.

In addition, problem posing is effective in improving problem-posing and problem-solving performance. This result was evident in the differences between pre-test and post-test scores in the class that participated in problem-solving learning, although there was no significant difference between the experimental and control classes [6]. These findings were also confirmed by [34], who reported that mathematics teaching using problem-posing strategies could enhance problem-solving skills, and by [11], who found that problem-solving ability is predicted by the quality of problem posing.

Another finding shows that problem posing combined with the Realistic Mathematics Education (RME) approach can improve written mathematical communication skills [33]. The study showed that problem posing with the RME approach was more effective in improving students' written communication skills than problem posing alone. However, problem posing without RME was still more effective than Direct Instruction (DI) in enhancing students' written mathematical communication abilities. This means that Problem Posing, when taught using the RME approach, will be more beneficial for mathematical written communication skills.

The next aspect that can be improved through problem posing activities is adaptive reasoning skills, as in the study by [32]. Interestingly, in that study, problem posing with a scientific approach was more effective at improving adaptive reasoning than problem-solving activities. This also indicates that problem posing can be effectively utilized to enhance students' adaptive reasoning skills when combined with a scientific approach.

Furthermore, another aspect that can be improved through problem posing activities is motivation [17]. The study found that students' learning motivation increased significantly through problem posing. This finding is also supported by [7] who applied Collaborative Problem Posing and Solving (CPPS) in mathematics learning, where a questionnaire revealed that it resulted in high motivation.

Apart from students, problem posing is also applied to prospective teachers. The study by [38] showed the success of problem posing in improving the pedagogical content knowledge of prospective teachers. This increase was measured through closed-ended items, which indicated that both content knowledge and pedagogical content knowledge of prospective teachers increased during the learning process.

In principle, these findings were obtained from experimental research that controlled various variables, thereby allowing the causal relationship between the independent and dependent variables to be accurately identified. This approach allows researchers to ensure that the variables studied truly influence the aspects under observation. On the other hand, other types of research, such as qualitative research, research and development (R&D), and action research, also make important contributions by generating new hypotheses. These hypotheses can be tested more systematically through quantitative-experimental approaches in subsequent research, thereby enriching scientific understanding.

Based on the results of [37], mathematical problem posing in real-world contexts can foster value and reduce boredom. Moreover, the same study found that problem posing on visual poetry can increase interest and enjoyment. This finding is very interesting because it can be extended to quantitative experimental research to answer whether problem posing in real-world contexts and visual poems can truly encourage value, minimize boredom, increase interest, and increase enjoyment in mathematics learning. To answer this, further research is needed, using quantitative experiments or mixed-methods designs, to convince practitioners in the field actually to apply problem posing. Additionally, based on [7] research, the application of Collaborative Problem Posing and Solving (CPPS) showed high acceptance from students. Through a Research and Development (R&D) study, Arif et al. [29] developed a Mathematics Learning Device with a Scaffolding-assisted Problem-Posing approach by lesson plans, teacher books, student books, student worksheets, and learning outcome assessment instruments. They found that these learning tools effectively improved students' characters, including curiosity, hard work, and responsibility. These findings are also worth further exploration through quantitative-experimental research to test the extent to which problem posing influences curiosity, hard work, and responsibility.

The findings above make valuable contributions to practitioners and researchers in mathematics education, particularly in implementing the problem-posing approach. For practitioners, the application of problem-posing in the classroom has been proven to enhance various aspects of learning, including learning achievement, problem-posing skills, critical thinking, creativity, mathematics, written communication skills, adaptive reasoning, pedagogical content knowledge for both teachers and prospective teachers, and learning motivation. These findings expand the evidence for the benefits of the problem-posing approach, as previously reported in the literature. Kul et al. [18], through a meta-analysis study, found that the problem posing strategy can significantly improve mathematics learning achievement, problem-solving skills, problem-posing skills, and attitudes toward mathematics. Another systematic study [19] using a Systematic Literature Review (SLR) approach concluded that problem posing has a positive impact on learning achievement, critical thinking, creative thinking, and learning motivation.

Meanwhile, Aktas [20], in a bibliometric study, revealed that problem posing contributes to the improvement of problem-posing and problem-solving skills, learning outcomes, attitudes toward mathematics, and conceptual understanding among prospective teachers. This study expands on previous research while reinforcing earlier findings by adding new benefits of problem posing that have not been extensively explained before: written mathematical communication skills, adaptive reasoning, and pedagogical content knowledge. Additionally, for researchers, this study opens the door to further research exploring the Influence of problem posing on important learning characteristics, such as curiosity, work ethic, and responsibility, through an experimental research approach.

3.2.2 Comparison of Aspects that Can Be Improved in Mathematics Learning through the Implementation of Problem Posing Between Indonesia and Abroad

The aspects that are improved through problem Posing consisting of cognitive and affective aspects, are as follows: Critical & Creative thinking, problem posing performance, problem solving performance, Mathematical thinking skill, Learning achievement, Modelling performance, Pedagogical content knowledge, Written mathematical communication skills, and Adaptive reasoning, as well as Interest, Value, Enjoyment, Boredom, Student acceptance, Motivation, Curiosity, Hard work, and Responsibility. In Indonesia itself, the aspects that are enhanced include critical and creative thinking, students' mathematical thinking skills, adaptive reasoning, written mathematical communication skills, student motivation, curiosity, hard work, creativity, and responsibility. Meanwhile, abroad, the aspects that are enhanced include Creativity, Problem Posing & Solving Performance, Learning Achievement, Student Modelling Performance, Pedagogical Content Knowledge, Students' Acceptance, Motivation, Interest, Value, Enjoyment, and Boredom.

Aspects that are developed in Indonesia but not found abroad include critical thinking, students' mathematical thinking skills, adaptive reasoning, written mathematical communication skills, curiosity, hard work, and responsibility. Conversely, aspects developed abroad but not found in Indonesia include Problem Posing and Solving Performance, Learning Achievement, Student Modelling Performance, Pedagogical Content Knowledge, Students' Acceptance, Interest, Value, Enjoyment, and Boredom. Among these aspects, there are two commonalities between Indonesia and abroad: Creativity and Motivation, which are developed in both places.

3.2.3 Comparison of Problem-Posing Learning Steps Between Indonesia and Abroad

In Indonesia, there are various steps in implementing problem posing. Toheri et al. [28] outline the learning steps starting with Situation Orientation, Creating Problems, Solving Problems, Class Discussion, and Practice. Arif et al. [29] did something different. He conducted learning where students did the following things: Follow the information closely from the teacher, Read/review information in the student book, Formulate the problem or question based on the information obtained, Formulate and solve problems in LKPD (Student's worksheet), Discuss/ask friends or teachers, Conclude the subject matter based on teacher guidance, and Pay attention to the feedback given by the teacher. Christidamayani and Kristanto [17] also compiled the learning steps as follows: Informing Learning Goals – Delivering learning objectives to students, Groups Formation – Forming study groups, Presenting Problems – Presenting problems to students, Posing Problems – Students are asked to create or modify problems based on given information, Solving the Problems – Students solve problems that they have created themselves.

Although the implementation of Problem Posing in Indonesia differs in its steps, there are three main steps in common: first, situation orientation. In this step, the teacher provides a situation to the students, which in another sense can be viewed as "Choosing a starting point." The second step is problem formulation. Here, students are asked to create problems from the given situation, either by creating new ones or modifying existing ones. The third step is for students to solve the problems they have created themselves. Toheri et al. [28] designed discussions and exercises for learning through problem posing. Arif et al. [29] also designed discussions, but explicitly used the LKPD (Student Worksheet) for the exercises.

Abroad, there are also various steps in implementing problem posing. Polat and Özkaya [6] describe their learning steps as follows: students pose a problem, the problem is solved, and finally, the data in the posed problem are modified so that students can pose a different problem. Martín-Díaz [5] implements problem posing with the following steps: First, Understanding the Situation – The teacher ensures that students understand the context of the given scenario. Second, Identifying Problem Elements – The teacher helps students recognize the data, context, and other elements needed for the problem. Third, Designing the Problem – Students are given time to organize relationships between these elements and build the problem. Fourth, Articulating the Problem – Students thoroughly articulate the problem, including the question to be answered. Fifth, Checking the Problem – Students attempt to solve the problem they created to ensure its coherence and meaning. Utami and Hwang [7] describe the following steps: First, Problem Construction – Students and the teacher design questions related to decimals in an authentic context. Students may use text, audio, and images to explain their questions. Second, problem-solving – Students choose and answer questions designed by other students or the teacher. They may also provide explanations using multimedia. Third, Peer Assessment – Students provide feedback on their peers' answers. Fourth, Group-Achievement Visualization – The system visualizes group achievement based on the number of questions posed, answers given, and peer assessments. Hartmann et al. [8] outline the following general steps: Students are given real-world situations; Students are asked to formulate mathematical problems based on those situations; Students are asked to solve the problems they created. Kovács et al. [11] describe the problem-posing steps as follows: First, Modeling – Processing new material; the teacher models examples and draws attention to the textbook. Second, Practice – Students find examples and solve problems based on the model. Third, problem posing – Students create problems with the same structure as the model. Fourth, problem Solving – The class discusses and solves the problems posed by the students. Sangpom and Sangpom [9] outline the following steps: First, grouping the students into 6 groups (for 30 participants). Second, the teacher provides information, situations, charts, and pictures, and encourages students to use mathematical knowledge to analyze and find relationships between the information in a given context, create problems or questions, and then solve the problems. Third, the teacher asks each group to exchange the problems they have formulated with other groups and to solve them. Fourth, three selected groups present their problems and the problems received from another group. Fifth, Students upload their assignments to Google Classroom, and the teacher gives feedback. Sixth, Q & A and discussion. Leavy and Hourigan [10] outline the following learning steps: Analyze the mathematical problem, Use problem hints to create problems, Formulate problems, then Reflection and consolidation.

In general, problem posing learning abroad involves three main steps: The teacher provides the situation (students understand the given situation), Students pose the problem, and students solve the posed problem. However, Martín-Díaz [5] in designing problem posing learning, introduced a step, "Identifying Problem Elements," where the teacher helps students recognize data, context, and other elements. Similarly, Sangpom and Sangpom [9] include a step that encourages students to use mathematical knowledge to analyze and identify relationships among the information in the given context. This suggests that before students pose questions or problems, the teacher guides students in analyzing the situation. This is not simply asking students to pose problems, which may seem unusual. After providing the situation, identifying the problem elements, and before asking students to formulate the problem completely, Martín-Díaz et al. [5] introduce a further step, "Designing the Problem". Students are given time to organize relationships between the elements and construct the problem.

The implementation of problem posing abroad, which is not seen in Indonesia, includes the steps "Identifying Problem Elements" and "Designing the Problem (before posing the problem)." Identifying problem elements, as seen in the problem-posing steps proposed by [40], corresponds to the steps "listing attributes" or "registering properties." In the "Designing the Problem" step, students begin formulating questions about the situation, but have not yet finalized the problem to be posed. Many questions may arise from analyzing the situation, but the students have not yet determined the final problem to be answered. In this case, students are considered to have posed a problem once they can articulate the problem clearly. On the other hand, the implementation of problem posing in Indonesia, which is not seen abroad, is the step "Exercise" in the research by [28], and the step "Read/review information in the student book" in the research by [29].

This study shows that there are differences in the steps taken to implement problem posing, both in Indonesia and abroad. These differences reflect the diversity of pedagogical approaches, curriculum contexts, and learning objectives sought by each researcher or practitioner. In Indonesia, the implementation of problem posing generally follows three main stages, namely situation orientation, problem formulation, and problem solving. However, in practice, each study designs its own unique learning steps. For example, Toheri et al. [28] added stages of class discussion and problem-solving exercises, while [29] incorporated the steps of reading textbook information and using worksheets as student work guides. Christidamayani and Kristanto [17] emphasize the formation of learning groups and teacher feedback as part of the learning structure.

On the other hand, international studies show a more exploratory tendency and a focus on in-depth context analysis. The steps for implementing problem posing in foreign studies, as described by [5] and [11], include additional cognitive stages such as "Identifying Problem Elements" and "Designing the Problem" before students are asked to formulate the problem completely. These stages are designed to help students understand the key elements in the given situation, organize relationships between pieces of information, and design problems that are more structured and meaningful. This approach demonstrates that problem posing is not merely a creative activity but also a systematic thinking process that can be enhanced through cognitive scaffolding.

4. CONCLUSION

The application of problem posing in mathematics learning demonstrates a wide range of positive impacts, particularly in enhancing both cognitive and affective domains.

Empirical evidence indicates that problem posing significantly improves students' critical thinking, creativity, problem-solving abilities, mathematical reasoning, academic achievement, and written mathematical communication. Simultaneously, it fosters the development of affective aspects such as motivation, interest, value orientation, enjoyment of learning, and a sense of responsibility. These findings underscore the strategic value of problem posing as a holistic and impactful instructional approach in mathematics education.

From a procedural standpoint, the structure of problem-posing practices in Indonesia and abroad is generally similar, typically involving: the teacher providing the situation (so students understand the given situation), students posing the problem, and students solving the posed problem. However, overseas implementations include additional steps, such as identifying problem elements and designing the problem structure before explicit formulation, steps not found in the problem-posing stages in Indonesia. Conversely, mathematics learning in Indonesia tends to rely more heavily on explicit textbook reading activities and structured, guided exercises.

The implications of these findings suggest the importance of adopting a more structured approach to problem posing, both in Indonesia and internationally, to improve students' creativity, problem-solving abilities, and conceptual understanding. However, the study has a limitation, as the literature review relied on a limited range of databases, namely Scopus, ERIC, and ScienceDirect, which may not encompass other, potentially broader databases that could offer a more comprehensive insight. To maximize the pedagogical impact of problem posing, future research and development should aim to synthesize diverse approaches by integrating the reflective emphasis and perseverance in learning observed in Indonesian practices with the explicit conceptual scaffolding and cognitive structuring prevalent in international contexts. Such cross-contextual collaboration holds significant potential to produce culturally adaptive and pedagogically enhanced learning models that are both effective and inclusive across diverse educational settings.

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Appendix 1. Articles Content

Article Number	Research Tittle	Author	Journal	Research Type	Content
1.	Creative thinking for learning algebra: Year 10 students' problem solving and problem posing with quadratic figural patterns	Karina J. Wilkie	Elsevier	Qualitative	1. Providing a series of tasks in the form of problem posing and problem solving involving quadratic figural patterns successfully revealed various student creative thinking characteristics, including flexibility, fluency, originality, and elaboration. 2. The majority of students preferred problem solving, but creative thinking aspects were more prominent in problem-posing activities.
2.	The effect of problem-posing-based active learning activities on problem-solving and posing performance: The case of fractions	Hatice Polat and Merve Özkaya	Journal of Pedagogical Research	Experimental	1. This study examined the improvement of problem solving and problem posing through a problem posing-based active learning intervention which included the following learning steps: First, (1) the students pose a problem, then (2) the posed problem is solved, and finally, (3) the data in the posed problem is changed so that the students can pose a different problem. 2. On the problem-solving test (PST), the experimental group showed an increase in average score after the intervention using problem-posing-based active learning. However, the increase was not statistically significant, indicating that although there was performance improvement, the difference was not strong enough to conclude that it was due to the given treatment. 3. On the problem posing test (PPT), there was a statistically significant increase in the experimental group after the intervention using problem-posing-based active learning from pre-test to post-test. This shows that problem posing-based learning is effective in improving students' ability to construct mathematical problems. Nevertheless, when compared with the control group, there was no significant difference between the two groups.

3.	Visual Poetry and Real Context Situations in Mathematical Problem Posing and Solving: A Study of the Affective Impact	Battaler, A., et al.	Mathematics MDPI	Qualitative	1. This study analyzes performance and affective responses (enjoyment, boredom, interest, and value) in problem-posing and problem-solving activities across three problem contexts: Near Real Context (NRC), Remote Real Context (RRC), and Visual Poem (VP). 2. Findings from this study show that the problem-posing activity in the visual poem context influenced enjoyment and interest. Meanwhile, the problem-posing activity in the NRC context influenced boredom, and the problem-posing activity in the RRC context influenced value. However, the affective aspects influenced by the problem-posing activity did not positively correlate with problem-posing performance in any of the NRC, RRC, or VP contexts. 3. Another finding in this study shows that the problem-solving activity in the RRC context influenced enjoyment, interest, and value. Meanwhile, the visual poem influenced boredom, and NRC did not affect affective aspects. However, problem-solving activities with NRC were more accessible than those with RRC and VP.
4.	Characterisers of Teaching in a Mathematics Problem-Posing Lesson in Preschool Education	Martín-Díaz, J.P., et al	Sustainability MDPI	Qualitative	1. This study shows that implementing problem posing in early childhood education can be done effectively with careful planning and well-defined implementation processes. 2. The problem-solving steps implemented in this study were: understanding the situation, identifying the problem elements, designing the problem, articulating the problem, and checking the problem.
5.	Teacher Support for Eliciting Students Mathematical Thinking: Problem Posing, Asking Questions, and Song	Kurniasih, A.W., et al	International Journal of Learning, Teaching and Educational Research	Qualitative	1. This study describes the stimuli used by 5th-grade elementary teachers to develop students' mathematical thinking abilities. These stimuli included problem-posing activities, asking guiding questions, using technology, and singing. 2. The problem-pose activity used in the stimuli that could develop mathematical thinking ability was that students were asked to create story problems, then to formulate questions beyond those already given.

6.	The impact of collaborative problem posing and solving with the ubiquitous-decimal app in authentic contexts on math learning	Utami, A.Q., & Hwang, W.	Journal of Computers in Education	Experimental	1. This study revealed important findings: students' learning behavior during CPPS (Collaborative Problem Posing and Solving) activities supported by a ubiquitous learning application called U-Decimal could improve students' learning achievement. 2. The steps of Collaborative Problem Posing and Solving (CPPS) supported by the U-Decimal application were: problem construction, problem solving, peer assessment, and group achievement visualization.
7.	Where Exactly for Enhancing Critical and Creative Thinking: The Use of Problem Posing or Contextual Learning	Toheri., et al	European Journal of Educational Research	Experimental	1. The problem posing, contextual learning, and expository learning models improved critical and creative thinking abilities. 2. The Problem Posing model was more effective at improving creative thinking, while Contextual Learning was more effective at improving critical thinking. 3. The problem posing steps implemented in the study: situation orientation, problem creation, problem solving, class discussion, and exercises.
8.	The Effect of Problem-Based Learning and Mathematical Problem Posing in Improving Students' Critical Thinking Skills	Darhim., et al	International Journal of Instruction	Experimental	1. Problem-Based Learning (PBL) and Mathematical Problem Posing (MPP) were more effective than conventional learning in improving critical thinking skills. 2. The problem posing steps implemented in this study were: (1) Choosing a starting point; (2) Listing attributes (registering properties); (3) What-if-not-ing (the question "what if not?"); (4) Question asking or problem posing, and (5) Analyzing the problem; and then they finish it.
9.	Create your own problem! When given descriptions of real-world situations, do students pose and solve modelling problems?	Hartmann, L., et al	ZDM – Mathematics Education	Qualitative	1. Context-based learning with a problem posing approach improves students' modeling performance. 2. The problem posing steps used in the study: Students are given real-world situations; Students are asked to formulate mathematical problems based on those situations; Students are asked to solve the problems they created.
10.	Elementary Preservice Teachers' Knowledge, Perceptions, and Attitudes Towards	Rosli, R., et al	Journal on Mathematics Education	Mixed method	The integration of problem posing, problem solving, and concrete models significantly improved Pedagogical Content Knowledge (PCK) and increased content knowledge. However, the increase was not significant, so many participants still had difficulty with the concepts of unit-whole, part-whole, and fraction operations.

	Fractions: A Mixed-Analysis				
11.	The Effectiveness of Learning Models on Written Mathematical Communication Skills Viewed from Students' Cognitive Styles	Chasanah, C., et al	Europan Journal of Educational Research	Experimental	The Problem Posing (PP) model with the Indonesian Realistic Mathematics Education (IRME) approach is as effective as the problem posing (PP) model for Written Mathematical Communication Skills (WMCS). However, the Direct Instruction (DI) model is more effective than the problem Posing (PP) model in students with Field Independent (FI) cognitive styles, and the problem Posing (PP) model is more effective than the Direct Instruction (DI) model in students with both Field Independent (FI) and Field Dependent (FD) cognitive styles.
12.	Incorporating Problem Posing into Sixth-Grade Mathematics Classes	Kovács, Z., et al	Education Sciences MDPI	Qualitative	1. The research results showed that most students were successful in problem-posing tasks based on previously worked problems. 2. This study also found a direct relationship between students’ success in problem posing and problem solving. 3. The problem posing steps implemented in this study were modeling, practice, problem posing, and problem solving.
13.	Development of a Mathematics Learning Device with Scaffolding-assisted Problem Approach to Improve Character Learners	Arif., et al	Universal Journal of Educational Research	Developmental (4-D model)	1. This research developed lesson plans, teacher books, student books, student worksheets, and learning outcome assessment instruments, and found that these learning tools effectively improved students' character traits, including curiosity, hard work, creativity, and responsibility. 2. The scaffolding-assisted problem posing approach steps conducted in this study were: Follow the information closely from the teacher, Read/review information in the student book, Formulate the problem or question based on the information obtained, Formulate and solve problems in LKPD (Student's worksheet), Discuss/ask friends or teachers, Conclude the subject matter based on teacher guidance, and Pay attention to the feedback given by the teacher.
14.	Enhancing Mathematics Achievement Through Online Problem Posing: A Study During the COVID-19 Pandemic	Sangpom, W., & Sangpom, N.	Educational Planning	Experimental	1. Online problem posing was effectively applied to enhance mathematics achievement. 2. The problem posing steps conducted in this study were: First, grouping students into 6 groups (30 participants). Second, the teacher provides information, situations, charts, and pictures, and encourages students to use

					mathematical knowledge to analyze and find relationships between the information in a given context, create problems or questions, and then solve the problems. Third, the teacher asks each group to exchange the problems they have formulated with other groups and solve them. Fourth, three selected groups present their problems, and the problems received from another group. Fifth, Students upload their assignments to Google Classroom, and the teacher gives feedback. Sixth, Q & A and discussion.
15.	Effect of Teaching Mathematics Supported by Problem-posing Strategies on Problem-posing Skills	Divrik, R.	International Journal of Modern Education Studies	Mixed method	The study concluded that teaching mathematics supported by problem-posing strategies can improve students' problem-posing skills.
16.	An Analysis of the Qualities of the Problems Posed by the Students in a Seventh Grade Mathematics Course Assisted by the Problem Posing Approach	Yığ, K.G., & Ay, Z.S	International Journal of Contemporary Educational Research (IJCER)	Qualitative	The study concluded that integrating the problem-posing approach into the education program can improve the quality of the problems students develop.
17.	Students' Understanding of A Geometric Theorem: A Case of Grade 9 Problem Posing	Patac, A.V., et al	Journal of Research and Advances in Mathematics Education	Qualitative	The research findings indicate that when mathematical symbols (such as formulas or notations) are not used, students find it more difficult to generate new questions about geometric theorems. Consequently, the way students construct and articulate problems can reflect the depth of their mathematical understanding. This suggests that problem posing has a significant Influence on students' mathematical comprehension within the context of geometry.
18.	Nurturing Problem Posing in Young Children: Using Multiple Representations within	Kwon, H., & Capraro, M.M.	International Electric Journal of Mathematics Education	Mixed Method	This study found that applying a problem-posing learning model involving hands-on manipulatives and multiple representations in real-world contexts can improve problem-posing skills.

	Students' Real-World Interest				
19.	The Effects of Problem-Posing Learning Model on Students' Learning Achievement and Motivation	Christidamayani, A.G., & Kristanto, Y.D.	Indonesian Journal on Learning and Advanced Education	Experimental	1. The study results showed that the problem posing learning model had no significant effect on students' learning achievement, but had a positive and significant effect on students' learning motivation. 2. The problem posing steps conducted in this study were: informing about the learning goals, group formation, presenting the problems, posing the problems, and solving the problems.
20.	Problem Posing and Problem Solving with a Scientific Approach in Geometry Learning	Andika, F., et al	International Online Journal of Education and Teaching (IOJET)	Experimental	1. The results showed that students who used the problem posing learning model with a scientific approach experienced a significant increase in adaptive reasoning. 2. The problem-Posing learning model with a scientific approach was better than the problem-Solving model with a scientific approach at improving adaptive reasoning.
21.	Attending to Task Variables When Engaging in Group Problem Posing for Elementary Level Mathematics	Leavy, A., & Hourigan, M	Journal of Mathematical Behavior	Qualitative	1. This study examined the role of problem situations and prompts introduced in a problem-posing intervention on the characteristics of problems constructed by groups of prospective elementary teachers for students in two fourth-grade classes. The findings showed improvements in the quality of the problems posed, influenced by several factors, including the use of textbook problems as initial problem situations that supported problem reformulation, the constructive role of prompts in focusing attention on desirable problem features, and the important role of feedback in determining the aptness of the posed problems. 2. The problem posing steps conducted in this study were: analyzing mathematical problems, using problem prompts to construct problems, constructing problems for elementary students, and reflection and consolidation.

Appendix 2. The meaning of Several Terms

1. The meaning of the term “problem posing” in each article

Problem posing found in this article is divided into two categories: problem posing as an activity/strategy/approach/learning model, and problem posing as a skill/performance. Problem posing as a strategy/activity/model has the same meaning as how problem posing is implemented in mathematics classrooms.

Article Numbers	Research Tittle	The meaning of the term “problem posing” as an activity
1	Creative thinking for learning algebra: Year 10 students’ problem solving and problem posing with quadratic figural patterns	Problem posing as an activity in mathematics learning in the classroom, where students are given tasks to create their own figural growing patterns (by drawing the first four pictures), then generalize them by finding at least one rule (equation).
2	The effect of problem-posing-based active learning activities on problem-solving and posing performance: The case of fractions	Problem posing is an approach to active learning in which students actively participate in formulating problems.
3	Visual Poetry and Real Context Situations in Mathematical Problem Posing and Solving: A Study of the Affective Impact	Problem posing is a mathematical activity in which students actively develop, propose, and formulate their own mathematical problems based on the context or information provided.
4	Characterisers of Teaching in a Mathematics Problem-Posing Lesson in Preschool Education	Problem posing is a learning activity in which teachers involve students in formulating questions from a given context.
5	Teacher Support for Eliciting Students Mathematical Thinking: Problem Posing, Asking Questions, and Song	Problem posing is an activity in which students generate (compose) mathematical problems based on the given context.
6	The impact of collaborative problem posing and solving with the ubiquitous-decimal app in authentic contexts on math learning	*Problem posing is the practice of having students create or compose their own mathematical problems based on the context or information provided.*

7	The impact of collaborative problem posing and solving with the ubiquitous-decimal app in authentic contexts on math learning	Problem posing is a mathematical learning approach in which students create problems based on given situations or information, then solve the problems themselves, and discuss them with their teachers and classmates.
8	The Effect of Problem-based Learning and Mathematical Problem Posing in Improving Students' Critical Thinking Skills	Problem posing is a learning activity in which students actively create or formulate their own mathematical problems based on information provided by the teacher.
9	Create your own problem! When given descriptions of real-world situations, do students pose and solve modelling problems?	Problem posing is an activity in which students create mathematical questions or problems based on specific information, situations, or contexts provided by teachers or learning materials.
10	Elementary Preservice Teachers' Knowledge, Perceptions, and Attitudes Towards Fractions: A Mixed-Analysis	*Problem posing is a mathematical learning activity in which students actively develop, modify, or compose their own problems based on information or situations provided by the teacher.*
11	The Effectiveness of Learning Models on Written Mathematical Communication Skills Viewed from Students' Cognitive Styles	The PP (Problem posing) is a learning model that helps students create many problems from the information they obtain, to be solved immediately.
12	Incorporating Problem-Posing into Sixth-Grade Mathematics Classes	Problem posing is an activity in which students create their own math problems based on the knowledge and understanding they have gained previously.
13	Development of a Mathematics Learning Device with Scaffolding-assisted Problem Approach to Improve Character Learners	Problem posing is an activity in which students pose questions or problems based on specific information or situations.
14	Enhancing Mathematics Achievement Through Online Problem-Posing: A Study During The Covid-19 Pandemic	Mathematical problem-posing is a guideline for designing and organizing mathematical learning activities.

15	Effect of Teaching Mathematics Supported by Problem-posing Strategies on Problem-posing Skills	Problem posing is defined as the activity of formulating problems related to a given situation or content."
16	An Analysis of the Qualities of the Problems Posed by the Students in a Seventh Grade Mathematics Course Assisted by the Problem Posing Approach	Problem-posing is an instructional design.
17	Students' understanding of a geometric theorem: A case of grade 9 problem posing	Problem posing is a learning activity in which students are asked to create (compose) their own math problems.
18	Nurturing Problem Posing in Young Children: Using Multiple Representations within Students' Real-World Interests	Problem posing is the process by which, based on mathematical experience, students construct personal interpretations of concrete situations and formulate them as meaningful mathematical problems.
19	The Effects of Problem-Posing Learning Model on Students' Learning Achievement and Motivation	Problem posing is a learning model in which students generate new problems or reformulate existing ones.
20	Problem Posing and Problem Solving with a Scientific Approach in Geometry Learning	Problem posing is a learning model that encourages students to create new questions or reformulate existing ones.
21	Attending to Task Variables When Engaging in Group Problem Posing for Elementary Level Mathematics	Problem posing as a learning model in mathematics learning
Conclusion: Problem posing in this term is an activity/strategy/approach/model of teaching and learning in the classroom		

The meaning of problem posing as a skill in every article that measures problem posing ability is the same: problem posing performance and problem posing skills.

Article Numbers	Research Tittle	The meaning of the term "problem posing" as skills
2	The effect of problem-posing-based active learning activities on problem-solving and posing performance: The case of fractions	Problem-posing performance is problem-posing skills measured through a Problem-Posing Test (PPT) comprising 9 open-ended items related to operations with fractions, aimed at assessing students' ability to generate mathematical problems.
12	Incorporating Problem-Posing into Sixth-Grade Mathematics Classes	Problem-posing skills are demonstrated when a student submits their work in accordance with the teacher's instructions, shows understanding of the model problem, and constructs an appropriate mathematical problem.
15	Effect of Teaching Mathematics Supported by Problem-posing Strategies on Problem-posing Skills	Problem-posing skills in this study refer to students' ability to generate mathematical problems across three formats: free, semi-structured, and structured. The test developed by the researcher consisted of 15 problem-posing tasks, equally distributed across structured (5), semi-structured (5), and free (5) formats. The inclusion of all three types aimed to assess students' problem-posing skills across these sub-dimensions. This test was designed to observe the development of students' knowledge, conceptual understanding, and reasoning as a result of formal mathematics education.
16	An Analysis of the Qualities of the Problems Posed by the Students in a Seventh Grade Mathematics Course Assisted by the Problem Posing Approach	Problem posing skills refer to the examination of problems involving linear equations posed by students enrolled in the course. To achieve this aim, the quality of the posed problems was evaluated. The topic of linear equations consists of three subtopics: the coordinate system, linear correlation, and linear equation graphs. The criteria considered in assessing the problems include clarity, mathematical accuracy, contextual originality, originality in terms of mathematical relationships, level of complexity, and relevance to the given situation.
18	Nurturing Problem Posing in Young Children: Using Multiple Representations within Students' Real-World Interests	Problem-posing skills refer to students' ability to formulate problems based on real-world information (e.g., pictures or menus) and to construct an appropriate setup—namely, an equation that corresponds to the posed problem and yields a correct solution. A problem was considered valid if both conditions were fulfilled.
21	Attending to task variables when engaging in group problem posing for elementary-level mathematics	Problem-posing skills are defined as the quality of the mathematical problems students generate.
17	Students' understanding of a geometric theorem: A case of grade 9 problem posing	Student understanding that emerged in this study regarding the problem that students pose modified the Torrance Test of Creativity (fluency, adaptability, and originality)
Conclusion: all "terms" related to problem posing refer to students' ability to generate problems.		

2. The meaning of the term "critical thinking."

Article Numbers	Research Tittle	The meaning of the term "critical thinking."
7	Where Exactly for Enhancing Critical and Creative Thinking: The Use of Problem Posing or Contextual Learning	The critical thinking that we use is adopted from Ennis with four indicators: 1) formulating the main issues, 2) analyzing arguments, 3) determining the strategy, and 4) concluding.
8	The Effect of Problem-based Learning and Mathematical Problem Posing in Improving Students' Critical Thinking Skills	The indicators of critical thinking skills used were analyzing problems, drawing conclusions and providing explanations, evaluating, and choosing problem-solving strategies.
Conclusion: Critical thinking in this article has the same meaning, even though the terms used for the indicators differ.		

3. The meaning of the term "creative thinking."

Article Numbers	Research Tittle	The meaning of the term "creative thinking."
1	Creative thinking for learning algebra: Year 10 students' problem solving and problem posing with quadratic figural patterns	Student creativity in mathematics Education includes fluency, flexibility, Novelty/originality, and elaboration.
7	Where Exactly for Enhancing Critical and Creative Thinking: The Use of Problem Posing or Contextual Learning	The study stated that creative thinking included innovative creativity (fluency, originality) and adaptive creativity (elaboration, the abstractness of titles, and Resistance to Premature Closure). Flexibility was eliminated, and two additional norm-referenced measures, abstractness of titles and resistance to premature closure, were added to the scoring system. Abstractness of titles measures the degree of abstractness of thought, going beyond mere labeling. Finally, resistance to premature closure measures the degree of openness to ambiguity and not jumping to hasty conclusions.
13	Development of a Mathematics Learning Device with Scaffolding-assisted Problem Approach to Improve Character Learners	Creativity = when students formulate problems or questions based on the information or situation provided
Conclusion: Article 13 defines creativity in general terms as the ability to create problems, whereas articles 1 and 7 define creative thinking in more specific terms, with almost identical indicators.		

4. The meaning of the term “learning achievement.”

Article Numbers	Research Tittle	The meaning of the term “learning achievement.”
6	The impact of collaborative problem posing and solving with the ubiquitous-decimal app in authentic contexts on math learning	Learning achievement is the outcome of students’ decimal learning in mathematics. The research topic was the addition, subtraction, and multiplication of decimals using number lines and rounding numbers.
14	Enhancing Mathematics Achievement Through Online Problem-Posing: A Study During The Covid-19 Pandemic	Mathematics achievement is related to learning achivement. The mathematics achievement test was developed based on the content of the teaching plan for the subject “Partial derivative” for undergraduate students of the electrical engineering faculty at Rajamangala University of Technology, Suvarnabhumi, to measure students’ learning achievement.
Conclusion: The term “learning achievement” has the same meaning, namely the output of mathematics learning in the spesific materials.		

5. The meaning of the term “Mathematical Thinking.”

Article Numbers	Research Tittle	The meaning of the term “mathematical thinking.”
5	Teacher Support for Eliciting Students Mathematical Thinking: Problem Posing, Asking Questions, and Song	Mathematical thinking is one of the abilities in mathematics proficiency mentioned by the OECD, which enhances the capacity to make estimates and handle rounding errors, measure and construct, collect and handle information, represent and interpret data, recognize and represent relationships mathematically, use algorithms and relationships, solve problems, and make decisions among students.
Note: The term “mathematical thinking” differs from “mathematical understanding” in Article 17. Students' understanding of Article 17 concerns problem-posing skills, whereas the mathematical thinking in this article (Article 5) concerns mathematics proficiency.		