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Problem Posing in Mathematics Education Research: A Systematic Review

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Abstract
Students' critical thinking skills, attitudes, confidence, and understanding of mathematical concepts can be improved through problem-posing activities. However, teachers' and students' skills in problem-posing are still at a moderate level. This study aims to review the concept of problem posing and explore empirical research results on mathematical problem posing. The criteria for selecting empirical studies are publications between 2015 and 2020, the main focus of studies on mathematical problem posing, conducted in educational institutions, and sample empirical studies among students and teachers. Twenty articles were selected through a systematic search of the "ERIC" database. The findings show differences in mathematical problem posing, creating a new problem statement, producing new questions, formulate meaningful mathematical problems posing new mathematical questions, a distinctive problem-solving process, mathematical imagination, and creative thinking between multiple answers. The research results show that eight research on problem posing was done on primary school students, where the remaining were on secondary school students. A total of 12 articles on problem posing were studied on teachers, were 8 of them were preservice teachers, and another three are on qualified teachers, and one was on both. The results of school students showed a mostly positive impact on students' achievements, creative thinking, critical thinking, and learning motivation in their respective domains. For teachers, out of the eight researches done, five articles imposed a negative result. Teachers had conceptual difficulties in problem posing. The problems they posed were the inappropriate, error, or failure to establish a part-whole relationship, and some posed problems that required an irrelevant strategy. Implications of the study are discussed.
Keywords: Problem Posing, Mathematics, Education, Students, Teachers

Introduction

Problem-posing is one of the goals in mathematics education. It has also been recognized as a critical intellectual activity in school mathematics education to produce a balanced mathematics curriculum. Based on the importance, many countries put much emphasis on problem-posing in

their educational curriculum. The National Council of Teachers of Mathematics (NCTM) in 2000 documented problem-posing is a critical problem-solving component. The school curriculum should allow students to develop their problems based on their schooling and beyond. For a past decade, research focused on the mathematics problems posed by students and teacher candidates about fractions (Crespo, 2003; Isik, 2011; Kilic, 2013; Kilic, 2015; Rizvi, 2004; Toluk-Ucar, 2009; Unlu & Ertekin, 2012), algebraic equations (Akkan, Cakiroglu & Guven, 2009; Isik & Kar, 2012; Aydogdu-İskenderoglu & Gunes, 2016), probability (Yildiz & Baltaci, 2015; Silber & Cai, 2017), absolute value (Guveli, 2015), ratio-proportion (Sengul & Katranci, 2015), sets (Sengul & Katranci, 2012) and geometry (Van Harpen & Sriraman, 2013; Lavy & Bershadsky, 2003) subjects.

Problem posing is closely related to mathematics competency, and this is one reason students should be allowed to work on their problems while learning math. The problem-posing model has the advantage that it enhances students' learning activities to be more active in learning and less frustrated and confident in solving problems (Setiawan et al., 2018). Moreover, Kojima et al (2015) supported that problem-posing is an essential skill that helps students solve problems. Similarly, Niss and Hojgaard (2019) stated that problem-posing is part of problem-solving competence. This means that to solve problems competently, students have to deal with the problems that require them to solve them and generate related problems.

Problem posing allows students to experience the essence of mathematical word problems (Kopparla & Capraro, 2018). A study conducted by Kopparla and Capraro (2018), which focused on a second-grade student, showed that the problem-posing responses helped informally access the students' thought processes, understandings, and performance. Much can be said that the study that explored the viability of using problem posing to understand the mathematical profile was successful. This shows that problem posing is a feasible and more flexible alternative to individual assessment, and its use may assist teachers in targeting specific deficiencies in their students' mathematics performance. Nevertheless, according to Cai, Hwang, Jiang, and Silber (2015), although most of the results support that students can generate exciting and promising mathematical problems, most of these problems are not cognitively challenging and are inherently content in textbooks.

According to Christidamayani and Kristanto (2020), problem-posing is one approach that can increase students' activeness in the mathematical learning process. In a study conducted by Christidamayani and Kristanto (2020), students showed more positive effects in their motivation in learning mathematics and thus improving the effectiveness of mathematics teaching and learning; however, results showed an insignificant impact on the students learning achievement. One possible explanation for this is the lack of students' experience in problem-posing education. Thus, this concludes that students must be provided with the opportunity to pose their problems in mathematics. It requires in-depth thinking. Hence it improves student critical thinking too (Arikan & Unal, 2015).

Teachers play a critical role in problem-posing activities. Teacher knowledge such as subject matter knowledge and pedagogical content knowledge has had a crucial influence on students' mathematical understanding and achievement, and therefore, teacher knowledge of problem-posing must be considered and developed to improve students' success in problem-posing activities and mathematical performance (Lee, Capraro, & Capraro, 2018). Teachers'

competency and knowledge in using and teaching problem-posing are influential factors that can influence students' conceptual understanding in problem posing. Nuha, Waluya support this, and Junaedi (2018), which states that to improve conceptual knowledge in problem posing, it should be accompanied by teachers' efforts to enhance the quality of teaching. Due to the many form of researches done on problem-posing, hence the main objectives for this study is:

- To review the concepts of problem-posing in mathematics education researches.
- To explore the empirical research results of problem-posing in mathematics education researches.

Methodology

A systematic literature review requires the process of identifying, selecting, and critically evaluating relevant empirical studies to answer the research questions clearly (Dewey & Drahota, 2016). It also refers to an analytical procedure to the analysis drawn from a related article's data and results. This survey is designed to synthesize empirical research findings related to problem-posing research in mathematics education. In this study, the review and analysis were performed using an electronic media electronic database named ERIC and was conducted between May 2020 and June 2020. There were five phases from Khan et al. (2003) being used in this review, as illustrated in Figure 1.

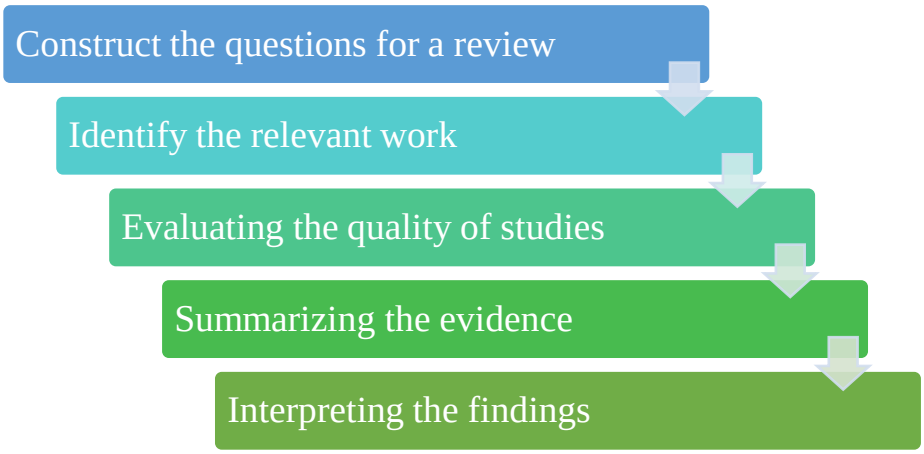

Figure 1 Phases of Systematic Literature Review

Phase 1: Construct the questions for a review

There are two questions formed for this review. The selected studies for this review were mainly studies conducted on problem posing in mathematics education. The two questions 1) What are the concepts of problem posing in mathematics education researches and also 2) What are the results of problem-posing in mathematics education researches? The purpose of reviewing the research findings is to enhance the future research goal and make room for improvement in future research.

Phase 2: Identify the relevant work

During the search for this review, two critical phases were included: collecting all the related articles based on the initial investigation and choosing relevant articles based on the inclusion

and exclusion criteria. The ERIC database was utilized in searching for the relevant articles. The articles were narrowed down to the range of 5 years between 2015 up to 2020. A few limitations were applied in the articles' search: English, peer-reviewed, and full-text articles. This is so that the most relevant articles will be identified. The following keywords were used in search of the article: "problem-posing" AND "mathematics", "problem-posing in mathematics", “problem generation in mathematics”, “problem generation” AND “mathematics”.

Phase 3: Evaluating the quality of studies

The inclusion and exclusion criteria were used to assess the quality of this review. The articles are focused on the research questions, methodology, and also the findings. The inclusion criteria for this review are as follows:

a) English full-text articles and peer-reviewed journal articles
b) published between the years of 2015 up to 2020
c) primary and secondary school students, preservice teachers, and also teachers.

For the exclusion criteria, studies were excluded if they were proceedings, dissertations, chapters, action research, and review research. If the studies are related to the two research questions, it would be included in this review. The research that determined issues outside of the theme framework were excluded. Secondly, articles must be empirical studies using quantitative, qualitative, or combinations as long as their respondents were primary or secondary school students, preservice teachers, and teachers. Lastly, the critical part was that the studies discuss the research results according to the research questions formed in this review.

Phase 4: Summarizing the evidence

This study aimed to collect any research that determined the concepts of problem posing and the problem-posing results based on mathematics education. As the first step of searching the articles, there were 1197 to be screened for the inclusion criteria that were English peer-reviewed and full-text articles. Next, the articles go through screening with other inclusion criteria is for respondents that were either primary or secondary school students, preservice teachers, and teachers. Then the exclusion criteria of articles that do not have full-text articles are done. Then, the dissertations, chapters, review papers, books were excluded from this review. Out of 1197 articles found in the initial step, only 20 articles were included to be analyzed in this review. The summarized details of the searching process were shown in the PRISMA diagram, as shown in Figure 2.

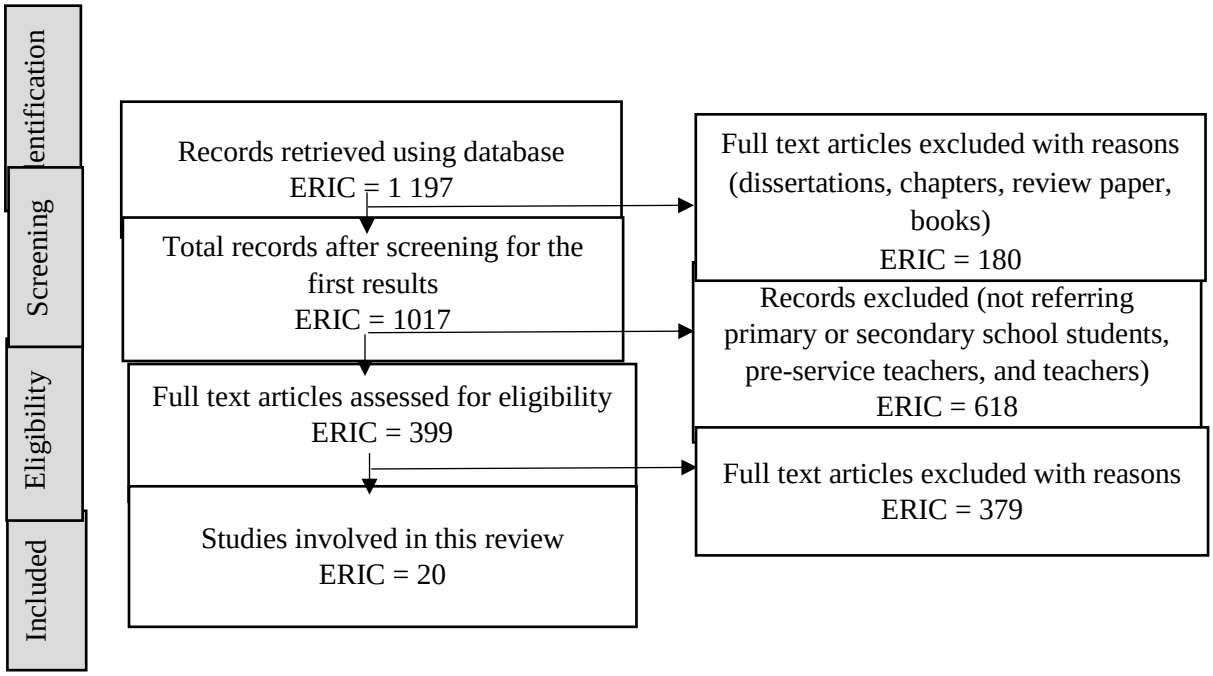

Figure 2: PRISMA flow chart

Phase 5: Interpreting the findings

As the first step, the researcher performed a vertical analysis process or "within-case analysis" of the 20 empirical research articles selected as the dataset. Through this vertical analysis, the unit of analysis on this procedure is the study article chosen. Each article is analyzed and compiled according to the classification of the scheme or criteria in the four aspects to be studied, namely year of studies, country of studies, concepts of problem posing in mathematics education research, and results of problem-posing activity in mathematics education research. The within-case analysis process is then followed by a cross-case analysis in which the unit of interpreting the data is two research questions and four aspects mentioned above.

Results

The discussion started with four aspects the year of studies, country, concepts of problem posing, and problem-posing activity in mathematics education research. The elements are taken into consideration due to the two research questions formed and also to find out the number of publications and the countries that published the most article which studies the issue of problem posing in mathematics.

Year of Studies

The findings show that majority of the studies were published in the year 2018, which is 7 out of the 20 articles analyzed. One each of the articles was published in the year 2015 and 2016, respectively. In 2017 and 2019, four papers were published for each year, and lastly, there were three articles published in the year 2020. It is believed that there are more research conducted in recent years after the National Council of Teachers of Mathematics (2000) and the National

Research Council (2005) include problem-posing in standard mathematics teaching strategies and curriculum in most of the countries (Kopparla & Capraro, 2018). The studies based on the publication year are presented in Table 1 below.

Year	Number of Articles	Researchers
2015	1	Arikan & Unal
2016	1	Tugrul Kar
2017	4	Melihan Unlu Manuel & Freiman Tuba Aydogdu İskenderoglu Cigdem Kilic
2018	7	Yilmaz, Durmus, & Yaman Azmi Nuha, Waluya & Junaedi Ozdemir & Sahal Mahati Kopparla & Margaret Capraro Tuba Aydogdu Iskenderoglu Unver et al. Yujin Lee, Capraro & Capraro
2019	4	Mehmet Koray Serin Cengiz Erdik Sumeyra Dogan-Cosku Kemal Ozgen
2020	3	Toheri, Winarso & Abdul Haqq Dwi Putra, Tatang Herman & Sumarmo Christidamayani & Kristanto

Table 1 Number of Studies Based on The Publication Year

Country of Studies

The findings in table 2 clearly show that most studies were conducted around the Asian continent comprising Turkey and Indonesia. The majority of the studies were conducted in Turkey. This could be due to problem-posing skills being adapted in mathematics education because of a reform enacted in Turkey in 2005 (Ministry of Education Singapore, 2006). Besides that, only a small number of studies were conducted in North America, comprising Canada and the USA. The number of studies analyzed in this review was two studies from the USA, while a study was conducted in Canada. This concludes that up to 85% of the studies are from the Asia continent, and the remaining were in the North America continent.

Continent	Country	Number of studies	Researchers
Asia	Turkey	13	Melihan Unlu (2017), Mehmet Koray Serin (2019), Arikan & Unal (2015), Yilmaz, Durmus, & Yaman (2018), Tuba Aydogdu İskenderoglu (2017), Cigdem Kilic (2017), Cengiz Erdik (2019), Sumeyra Dogan-Cosku (2019), Ozdemir & Sahal (2018), Tugrul Kar (2016), Kemal Ozgen (2019), Tuba Aydogdu Iskenderoglu (2018), Unver et al. (2018)
	Indonesia	4	Azmi Nuha, Waluya & Junaedi (2018), Toheri, Winarso & Abdul Haqq (2020), Dwi Putra, Tatang Herman & Sumarmo (2020), Christidamayani & Kristanto (2020)
North America	Canada	1	Manuel & Freiman (2017)
	USA	2	Mahati Kopparla & Margaret Capraro (2018), Yujin Lee, Capraro, & Capraro (2018)

Table 2 Country of Studies

Concepts of Mathematical Problem Posing

Based on the first research question, reviewing the concept of problem posing in mathematics education research, the first part of this study presents an analysis of the interpretation of the definition or concepts of mathematical problem posing presented by selected empirical studies (Table 3).

Concepts of Problem Posing	Number of Articles	Researchers
Creating a new problem statement using a given situation or restructuring a given problem statement	11	Melihan Unlu (2017), Arikan & Unal (2015), Mehmet Koray Serin (2019), Yilmaz, Durmus, & Yaman (2018), Cigdem Kilic (2017), Sumeyra Dogan-Cosku (2019), Toheri, Winarso & Abdul Haqq (2020), Ozdemir,& Sahal (2018), Tugrul Kar (2016), Christidamayani & Kristanto (2020), Yujin Lee, Capraro, & Capraro (2018)
Producing new questions to clarify a given situation and creating new problems based on a problem's solution.	2	Mehmet Koray Serin (2019), Christidamayani & Kristanto (2020)
Posing new mathematical questions of interest to investigate	3	Manuel & Freiman (2017), Azmi Nuha, Waluya & Junaedi (2018), Mahati Kopparla & Margaret Capraro (2018)
A distinctive perspective regarding the problem-solving process, which helps with the comprehension of the relationship the problem entails	2	Tuba Aydogdu İskenderoglu (2017), Kemal Ozgen (2019)
Transitions between representations contribute to the establishment of the relationship between processes and everyday life	1	Cengiz Erdik (2019)
Problem formulation to explain when some parts of the given problem are changed	5	Sumeyra Dogan-Cosku (2019), Yujin Lee, Capraro & Capraro (2018), Christidamayani & Kristanto (2020), Mehmet Koray Serin (2019), Cigdem Kilic (2017)
Mathematical imagination that could be enhanced by arousing new question, creating new possibility, and viewing the old problem from a new point of view	1	Dwi Putra, Tatang Herman & Sumarmo (2020)
A synthetic activity that fundamentally has multiple answers, and as such, it requires creative thinking between multiple answers	2	Tuba Aydogdu Iskenderoglu (2018), Unver et al. (2018)

Table 3 Concepts of Mathematical Problem Posing

The findings of table 3 show diverse interpretations of mathematical problem posing across studies. Some studies define problem-posing as creating a new problem statement using a given situation, producing new questions, problem formulation, and generating new mathematical questions of interest. The remaining studies conceptualize problem-posing as a distinctive perspective regarding the problem-solving process and transitions between representations to establish the relationship between processes. Also, a study signifies problem-posing as a mathematical imagination that could be enhanced by arousing new questions and a synthetic activity that fundamentally has multiple answers that require creative thinking. This understanding is in line with Polya's model of problem-solving. To generate new problems, Polya proposes to use a variety of heuristics for the 'revise answer' stage. While this demonstrates the problem-posing method, Gonzales in 1998 improved the fifth stage in the Polya solution model, namely, the generation of problem-solving. Four articles mentioned problem posing as the fifth step of Polya's problem-solving step, which was described by Gonzalez (1998): Melihan Unlu (2017), Mehmet Koray Serin (2019), Yilmaz, Durmus, and Yaman (2018), and Ozdemir & Sahal (2018). Besides that, many adapted the definition and concept of problem-posing from Silver (1994), who defined problem posing as creating a new problem statement using a given situation or restructuring a given problem statement and a problem formulation parts of the given problem are changed.

Results of Problem Posing in Mathematics Education Researches.

Based on the second research question, reviewing the results of problem posing in mathematics education research, table 4 below presents the results categorized based on the respondents targeted for each study.

Respondents	Results	Researchers
Primary School Students	• most students presented at least one alternative way of solving the fraction problems (gifted and non-gifted students) • a strong correlation between multiple problem solving and problem posing capability	Arikan & Unal (2015)
	• the problem-posing approach created a peaceful competition environment and increased participation in the classroom • positive effect on the academic achievement in teaching integers, but it did not have a significant impact on student attitudes towards mathematics	Ozdemir & Sahal (2018)
	• problem-posing a useful tool with which to evaluate misconceptions and to explore student's informal mathematics understanding	Mahati Kopparla & Margaret Capraro (2018)
Secondary School Students	• students could implement more than one mathematical concept within a problem. • problems created for this study were problems with contexts, problems with multiple strategies, and problems with multiple steps	Manuel & Freiman (2017)
	• the problem-posing model with lesson study approach in the digital class had the quality to improve creative thinking	Azmi Nuha, Waluya & Junaedi (2018)
	• Problem-posing and contextual learning are more effectively used to improve critical thinking and creative thinking than expository understanding. • problem posing learning enables the development of creative thinking better than contextual learning	Toheri, Winarso & Abdul Haqq (2020)
	• problem posing learning model has an insignificant effect on the students' learning achievement but has a positive and significant and positive impact of the learning model on the students' learning motivation (students' interests, enthusiasm, diligence, collaboration, and self-control)	Christidamayani & Kristanto (2020)
	• Improvement of students' mathematical problem posing ability using SA-WIN was better than students who used conventional teaching. • Student mathematical problem posing scores are at a medium level. Most students who use conventional teaching have difficulties in solving problems in the test. • Learning using SA-WIN encourages students to be active in asking questions, discussing, and solving MPP problems.	Dwi Putra, Tatang Herman & Sumarmo (2020)

Preservice teacher	• preservice teachers had more conceptual difficulties in problem-posing about the division of fractions than in problem-posing about the multiplication of fractions	Tuba Aydogdu Iskenderoglu (2018)
	• Prospective teachers were found to experience difficulties in selecting appropriate stories for the structures of the linear graphs and accurately conveying the data in the graphs through their stories. • Errors identified in the problems posed, the failure to express linearity was the most common. • success in problem-posing declined as the complexity of the data in the graphs increased	Tugrul Kar (2016)
	• although most of the preservice elementary teachers were able to pose problems, less than one-fourth of these problems were appropriate for the given symbolic form of the addition of fractions • preservice elementary teachers were more successful in posing part-part-whole problems than in posing join problems. • In terms of error types, the majority of preservice elementary teachers made the error of failure in establishing a part-whole relationship	Sumeyra Dogan-Cosku (2019)
	• 55% of the participants could pose a word problem that can be solved using the desired strategy. • Other participants displayed three forms of difficulty: some posed problems that required an irrelevant strategy, some were unable to offer any answer, and some suggested problems that involved simply finding a general rule of a pattern.	Cigdem Kilic (2017)
	• Preservice teachers' performances when posing pattern problems based on different representations differed according to their knowledge levels and a student level. • preservice teachers' performances when posing pattern problems using different representations at their levels was higher than their performances when posing problems at a student level	Yilmaz, Durmus, & Yaman (2018)
	• Findings have revealed that the preservice teachers less preferred real-life problems than a routine type of problems and the problems at the level of reasoning than the problems at the levels of knowing and applying. • preservice teachers do not adequately use real-life problems and problems at the level of reasoning, and that there are deficiencies in their mathematical content	Mehmet Koray Serin (2019)

	knowledge depending on their understanding of the curriculum	
	• Although some teacher candidates know problem-solving strategies, they did not pose a problem, and in some cases, they made mistakes in solving the problems they posed. • Many teacher candidates stated that they posed similar problems they saw in textbooks rather than act creatively.	Melihan Unlu (2017)
	• The groups' modeling problems were appropriate to real life, understandable, and exciting. Their problems directed students to construct a mathematical model, use real-life data, and visualize with the figures. • When the participants posed their problems, they paid attention to their content and the fact that the problem was interesting, understandable, and appropriate for real life.	Unver et al. (2018)
Qualified teachers	• many of the teachers have used ready-made problems and even mixed the concepts of problem and practice • using ready problems is due to insufficient knowledge of the field, due to necessity, because of the student's level, inadequate situations, and meaningfulness	Cengiz Erdik (2019)
	• The fact that nine distinct types of errors were observed in the study reveals that the teachers have significant shortcomings when posing problems regarding subtraction with fractions.	Tuba Aydogdu İskenderoglu (2017)
	• participants had subject matter knowledge of problem posing, but their actual problem-posing results did not reflect their subject matter knowledge well • In terms of knowledge of content and students (KCS) and knowledge of content and teaching (KCT), teachers were aware of the importance of problem posing for students' mathematical development but felt that several significant factors were impeding the effective incorporation of problem-posing within their classes	Yujin Lee, Capraro & Capraro (2018)
Preservice teachers and qualified teachers	• problems posed by the participants were mostly open-ended problems. • Findings showed that the posed problems were more about change-relationships and space-shape concerning mathematical content. • Findings suggest that the teachers are more successful than preservice teachers in problem-posing activities for mathematical literacy.	Kemal Ozgen (2019)

Table 4 Results of Problem Posing In Mathematics Education

Analysis done on these 20 articles found eight studies on problem posing were done on students from primary school, where the remaining were on secondary school students. A total of 12 articles on problem posing were studied on teachers, in which 8 of them were preservice teachers, and another three are on qualified teachers. An article focused on both preservice and also qualified teachers. Based on the result analysis on all the mathematics education research on problem posing, it is difficult to conclude students' achievement in problem posing. As seen in the study of Manuel and Freiman (2017), it is shown that the students, both gifted and non-gifted, were able to implement more than one mathematical concept within a problem. They were also able to pose problems with multiple strategies and problems with various steps. The study was similar to Arikan and Unal's (2015) study that found the relationship between problem-solving ability using multiple methods and problem-posing ability. The students were satisfied with only one solution rather than seeking alternatives; students preferred to solve the problems and not pose new ones.

For primary school students' results, it is noticeable that all the problem-posing activity implied to the respondents showed positive effects on students' achievements in their respective domain. It also increases the relationship between problem-solving and problem-posing capability. However, in the study done by Ozdemir and Sahal (2018), even though there is a positive effect on teaching integers' academic achievement, it did not significantly affect student attitudes towards mathematics. Research suggests that this could be due to the short duration of teaching; hence, there was not enough time for changes in the students' attitudes.

The results shown for secondary school students on problem posing all showed a positive impact for students in all aspects except for one study done by Christidamayani and Kristanto (2020). The studies' factors are mathematical concepts within a problem, creative thinking, critical thinking, learning motivation, and problem-solving. Christidamayani and Kristanto (2020) findings showed an adverse result on the students' learning achievement. It states that the problem-posing learning model has an insignificant effect on the students' learning achievement but has a positive and significant positive impact on the learning model's learning motivation. Critical and creative thinking can be improved through thinking exercises during the learning process (Bostic et al., 2016). Based on these findings and the importance of motivation on students' learning and learning achievement, problem-posing activity is a promising strategy to facilitate students (Christidamayani & Kristanto, 2020).

Moving on to the research done on preservice teachers, the analysis of results shows mostly a negative effect of preservice teachers' knowledge and experience on the problem-posing activity. Out of the eight research done, five studies found an undesirable impact than the other three studies. The results showed the teachers had conceptual difficulties in problem-posing. The problem posed was inappropriate, error of failure in establishing part-whole relationship, some posed problems that required an irrelevant strategy, and not adequately using real-life problems. Additionally, the studies also showed deficiencies in teachers' mathematical content knowledge depending on their understanding of the curriculum. Lastly, they posed similar problems they saw in textbooks rather than act creatively.

On the other hand, the positive results showed in a study by Cigdem Kilic (2017), Yilmaz, Durmus and Yaman (2018), and Unver et al. (2018). They found teachers could pose a word problem that can be solved using the desired strategy. The preservice teachers' performances when posing pattern problems using different representations at their levels was high. When posing a problem, the teachers paid attention to its content and the fact that it was interesting, understandable, and appropriate for real life.

For the category of qualified teachers, the results show negative points on all the three researches done. In all these studies, analysis shows that the participants used ready-made problems and even mixed the problem and practice concepts—insufficient knowledge of the content where teachers have significant shortcomings when posing problems. Even participants had subject matter knowledge of problem-posing; their actual problem-posing results did not reflect their subject matter knowledge well. Teachers were aware of the importance of problem posing for students' mathematical development but felt that several significant factors impeded the effective incorporation of problem-posing within their classes. Lastly, Ozgen (2019) research, which compared problem-posing skills for mathematical literacy between qualified teachers and pre-service teachers, showed that teachers are more successful than preservice teachers in problem-posing activities for mathematical literacy. From the analysis of the problem-posing results in mathematics education research, out of 20 articles, about 10 of the articles showed negatives results. The rest showed some positive results; most studies were done on students. Failure to remedy the conceptual weaknesses observed in this study might significantly affect the education teachers will provide to their students (Tuba Aydogdu Iskenderoglu 2018). These findings raise the question of whether or not teachers either preservice or qualified teachers, are aware of the meaning of problem-posing activities incorporated into mathematical problems.

Discussion

Based on the first objective, the survey found that all of the selected empirical studies had different interpretations of mathematical problem posing concept, which is creating a new problem statement, producing new questions, formulate meaningful mathematical problems posing new mathematical questions, a distinctive problem-solving process, mathematical imagination and also requires creative thinking between multiple answers. This is in line with a study conducted by Santos-Trigo, Reyes-Martínez, and Ortega-Moreno (2015), which has found that one of the objectives of mathematics activities is to identify and distinguish various methods and strategies for representing, exploring, and also generating new problems. Problem posing can be defined as a learning model that emphasizes students' ability to build on their creativity based on the teacher's situations, make the knowledge and share it with other students. This statement can be supported by Singer et al. (2013), which state that problem-posing enhances creativity in students and enhances students' talents in self-learning. From the findings, it has been proven that the interpretation provided in the definition of mathematical problem posing is essential and has influenced the use of models and problem-posing strategies in this field. Both are crucial to the development of concepts in posing mathematical problems. Based on Setiawan et al. (2018), the problem-posing model has advantages. It can enhance student learning activities so that they are more active in learning and do not easily give up, and have confidence in solving any problem. Simultaneously, the differences in the concept of problem-posing affect

the method and method of research carried out by each empirical study. This directly impacts the findings of the second research question of the systematic literature on the results of empirical research in mathematical problem posing.

The next discussion will be on the results of problem posing in mathematical education researches. Based on the findings, it is shown that most of the results are more or less the same with each other. According to Palmer et al. (2020), problem-posing is part of the problem-solving process. Moreover, according to Palmér et al. (2020), problem posing is closely related to problem solving because students' mathematical activities where students ask questions or problems deepens the students' understanding of mathematics content and their understanding of problem-solving processes. This can be seen in the results by Arikan and Unal (2015), Manuel and Freiman (2017), and Dwi Putra, Tatang Herman, and Sumarmo (2020), which shows the positive increase of student problem-solving ability based on their problem-posing capability. Furthermore, the integration of problem posing had a significant positive impact on students attitudes towards mathematics (Ozdemir & Sahal 2018), creative thinking (Nuha, Waluya & Junaedi 2018), improve the ability of critical thinking and creative thinking (Toheri, Winarso & Abdul Haqq 2020) and also students learning motivation (Christidamayani & Kristanto 2020). This is supported by Setiawan et al. (2018), which states that the problem-posing model has the advantage that it enhances students' learning activities to be more active in learning and less frustrated and confident in solving problems. Critical and creative thinking can be improved through thinking exercises during the learning process (Bostic et al., 2016). This shows that structuring the problem posing approach by adopting innovative strategies and technologies may make problem-posing more effective in facilitating students' learning (Christidamayani & Kristanto 2020).

The problem-posing in mathematical education research showed dissatisfaction in the results. Teachers lacked conceptual knowledge in specific domain areas of mathematics. Results also showed that teachers were found to experience difficulties in selecting stories that were appropriate for the structures of mathematical problems, some posed problems that required an irrelevant strategy, do not adequately use real-life problems and problems at the level of reasoning, and also posed similar problems they saw in textbooks, rather than act creatively. This is also similar to a study by Ozgen (2019), whereby it shows the difficulty of the problem posed by both pre-service teachers and even teachers. Results show that the participants' problems were mostly concentrated at level 4 (level of difficulty). It was understood that the participants' problems were at level 4 and later on level 3. At the highest levels, level 6 and level 5, a limited number of teachers and preservice teachers pose problems. It turns out that mathematic teachers are challenged in problem posing. This can also be seen in Cankoy (2010) studies, which states that researchers have found that several teachers have difficulty in integrating problem-posing in their classrooms. Providing teachers with problem-posing activities may increase their awareness of its importance and improve their abilities to pose appropriate problems. Singer and Voica (2012) supported this statement, which states that teachers must acquire problem-posing experiences if they intend to provide new and different learning experiences to their students. Utilizing these courses, teachers would know how to incorporate problem-posing activities into their future classrooms.

Conclusion

In sum, the results showed the main aspects and characteristics of students and teachers related to mathematical problem posing can contribute to excellence in mathematics education. This study's findings help teachers and educators identify deficiencies, levels of acceptance, and students' ability to pose mathematic problems and their shortcomings.

This systematic review demonstrates the main concepts of problem-posing and also the results of applying problem-posing skills in mathematics on many levels of education. The results of problem-posing in mathematics education researches shows that others must begin to consider the inclusion of problem-posing skills in the mathematics instruction especially for the pre-service teachers and teachers. It also makes it possible for educational institutions to implement this skill to the next step in the mathematics education world. This paper contributes by showing the amount of attention needed not only by the students but also on the teachers with the knowledge of the benefits of problem-posing and their ability to pose problems to prepare them for the future mathematics lesson. Suggestions and improvement on the multiple ways to incorporate problem-posing during a lesson could be variated based on the results collected on problem-posing in mathematics.

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