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The Effectiveness of Problem-Posing Learning Model in Terms of Creative Thinking Skills and Math Anxiety

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Abstract:
This research aims to analyze the effectiveness of problem-posing in terms of creative thinking ability and math anxiety simultaneously as well as analyze the difference in effectiveness between problem-posing and scientific in terms of creative thinking ability and math anxiety simultaneously. Quantitative research type quasi-experimental with a posttest-only control group design was conducted on grade X students at one of the State Senior High Schools in Wonogiri Regency, Central Java Province, Indonesia. The research samples were selected randomly from 11 classes and obtained two classes X1 and X3, each with 36 students. Data on creative thinking were obtained through essay tests, which included fluency, flexibility, and novelty aspects. Math anxiety data were obtained through a Likert-scale questionnaire with psychological, cognitive, affective, and attitude aspects. The study results showed that problem-posing was simultaneously effective in creative thinking and math anxiety. However, there was no difference in effectiveness between problem-posing and scientific in students' creative thinking and math anxiety. Following this result, there are research opportunities regarding analyzing the relationship between the level of math anxiety and creative thinking in solving problems based on higher-order thinking skills.

Keywords: creative thinking, effectiveness, math anxiety, problem posing, quasi experiment

1. Introduction

Education in Indonesia is currently required to prepare creative students as part of global competence to face challenges (Mendikbudristek, 2022). The challenges in the 21st century make creative thinking skills important to develop as a key to finding ideas and applying new findings of solutions to problems (Sharma, 2015). Creative thinking skills are defined as a person's ability to do a series of cognitive activities based on objects, problems, and specific conditions, or a type of person's efforts towards a problem based on their skills (Birgili, 2015). Another notion of creative thinking skills is a combination of imagination, hypothesis, synthesis, investigation, and application of new ideas in finding solutions to a problem (Sanders, 2016).

One of the subjects that require creative thinking skills is mathematics as it needs exploration activities and seeking abstractions from the relationships between patterns in a problem (Golding, 2018). In the context of mathematics learning, creative thinking skills are the ability to formulate new ways or solutions to mathematical problems (Siswono, 2018). The novelty of the thinking results may be the modification from the combination of previously existing elements in the problems (Utami, 2012). To identify and analyze a person's level of creative thinking, 3 aspects can be used: fluency, flexibility, and novelty (Silver, 1997).

The results of a survey on Trends in International Mathematics and Science Students (TIMSS) showed students' creative thinking skills level in Indonesia (score 397) is still below the low category (score 400), interpreted as only understanding basic mathematical knowledge (Mullis et al., 2015). Previous research results also showed that the creative thinking skills of students in Indonesia are still in the low category in each aspect of fluency, flexibility, and novelty (Kulsum et al., 2019; Maryati & Nurkayati, 2021; Wardani & Suripah, 2023). The student's low level of critical thinking is partly due to rarely given non-routine problems with various methods and answers in learning (Handayani et al., 2018). During learning activity in the classroom, most teachers tend to conduct activities that do not support student creativity, such as explaining and giving examples (Kasirer & Shnitzer-Meirovich, 2021).

The student's creative thinking skills are not influenced only by cognitive factors but also by psychology, like math anxiety. Math anxiety is a feeling of fear or negativity that many people experience when they are faced with solving math problems (Maloney et al., 2014; Radišić et al., 2015). Math anxiety is also described as a feeling that shows anxiety, considers math difficult, and is afraid of failure, hence it hinders calculations, exploration abilities, and the process of solving math problems in academic situations and daily life (Mutodi & Ngirande, 2014; Sousa, 2015). As a series of complex multidimensional aspects, math anxiety is seen as having aspects in the psychological, cognitive, somatic, and affective domains that are interrelated (Zeidner & Matthews, 2010).

Math anxiety that continuously increases can make students unable to learn well if the teacher is oblivious (Sepehrianazar & Babaee, 2015). Students' math anxiety can be influenced by teacher attitudes, curriculum, ineffective learning strategies, assessments, and classroom situations that do not involve students actively (Sousa, 2015). One of the strategies that teachers can make to reduce anxiety in learning mathematics is by implementing a learning model that encourages students to be actively involved (Finlayson, 2014). Student involvement in every learning activity allows students' math anxiety to decrease (Beilock & Maloney, 2015). Teachers can integrate contextual problems to make students understand the benefits of learning mathematics and foster a feeling of interest in mathematics (Das & Das, 2013). Student involvement in the learning process will not appear by itself but requires a process of habituation (Nasrullah & Marsigit, 2016).

Strategies that can be done to make students active include implementing the problem-posing learning model. Problem posing in mathematics learning is viewed as an activity that asks students to develop or create mathematical problems while solving the problems that have been created (Siswono, 2018). The problems developed by students can come from previously given problems or construct new ones (Dwita & Sugiman, 2020). The syntax of problem-posing consists of 3 phases: the initial instruction phase, the problem-posing phase including think and tag and share and tag, and the advanced phase. In the think and tag activity, students in groups create problems or questions based on the information provided, while in the share and tag activity, students exchange problems with their friends and work on problems from others.

According to previous research, problem-posing is useful in identifying students' lack of knowledge and paving the way for building knowledge through self-exploration in learning activities (Mishra & Iyer, 2015). Problem-posing has also been shown to be effective in making students happier in learning, reducing math anxiety, and fostering students' reasoning and creativity skills (Bicer et al., 2020; Cai & Leikin, 2020; Lorensia & Wea, 2015; Silver et al., 1996; Suryanti et al., 2020). Learning is effective if it achieves the expected goals, in this case, students achieve the knowledge and skills that have been planned by the teacher (Arends & Kilcher, 2010). One of the criteria for effectiveness in learning is the achievement of the determined score before learning (De Maeyer et al., 2010).

Based on previous studies, problem posing is effective in terms of student's creative thinking skills and math anxiety but is not done simultaneously. As mentioned earlier, math anxiety also affects creative thinking skills. Therefore, the author is interested in implementing the problem-posing learning model to test its effectiveness on creative thinking skills and math anxiety simultaneously for high school students. In this study, the material used was sequence and series material which is one of the materials that has many contexts of real-world problems. In addition, the author also analyzed the difference in the effectiveness of the problem-posing learning model with scientific learning model in terms of students' creative thinking skills and math anxiety. The selection of the scientific learning model as a comparison is because it has been applied in daily learning so that students are used to it.

2. Method

This study used a quasi-experimental quantitative approach with a posttest-only control group design because the placement of participant was done randomly (Creswell, 2012). The study was conducted on class X students at one of the State Senior High Schools in Wonogiri Regency, Central Java Province in the 2023/2024 academic year. The participant was selected using a random sampling technique so that 2 classes were obtained from 11 classes, namely class X1 as the experimental group of 36 students and class X3 as the control group of 36 students. The experimental group was given treatment with the problem-posing learning model, and the control group was given treatment with the scientific learning model. The problem-posing learning model refers to the design of Mishra & Iyer (2015). The research procedure began with the sample selection, gave treatment to both classes with a learning model of 5 meetings on the material of arithmetic and geometric sequences and series, then a test of creative thinking skills and math anxiety.

Data on students' creative thinking skills were obtained through tests while data on students' math anxiety were obtained through questionnaires. The test of creative thinking consisted of 5 essay questions, developed referring to Silver's creative thinking skills aspects, namely fluency, flexibility, and novelty as in Table 1 (Silver, 1997). Meanwhile, the math anxiety questionnaire consisted of 12 statements using a 5-choice Likert scale from never (1) to always (5). The math anxiety questionnaire was developed based on aspects according to Zeidner and Matthews (2010) namely psychological, cognitive, somatic, and affective as in Table 1.

Table 1. Aspect of creative thinking and math anxiety

Variable	Aspect
Creative thinking	Ability to identify information and express ideas or concepts in solving problems correctly (fluency)
	Ability to use multiple problem-solving strategies (flexibility)
	Ability to create new and different ideas/solutions that have never been taught in class and be able to solve problems using new methods (novelty)
Math anxiety	Feelings experienced in learning mathematics (psychology)
	Disorders regarding thinking abilities in mathematics learning (cognitive)
	Physical conditions during mathematics learning (somatic)
	Enthusiasm in learning mathematics (affective)

The test instruments and questionnaires in this study have been validated through a content validity by 2 doctoral lecturers from the Mathematics Education Department of Yogyakarta State University and have been deemed fit for use. The results of the Cronbach's alpha reliability test on the creative thinking test instrument ($\alpha = 0.778$, $n = 20$) showed high reliability ($\alpha > 0.60$). Meanwhile, the reliability test for the math anxiety questionnaire ($\alpha = 0.853$, $n = 72$) showed very high reliability ($\alpha > 0.80$). Therefore, the instrument is eligible for testing.

The data analysis techniques used in this study were descriptive analysis (mean and standard deviation) and inferential statistical analysis. The learning model is effective in terms of creative thinking ability ($\mu \geq 70$) or the initial limit of the high category in the range of 0-100 and effective in terms of math anxiety ($\mu \leq 31.2$) or the final limit of the low category in the range of 12-60 as in Table 2.

Table 2. Category of creative thinking and math anxiety (Azwar, 2016)

Category	Interval	
	Creative thinking	Math anxiety
Very high	$X > 90$	$X \geq 50.4$
High	$70 \leq X < 90$	$40.8 < X \leq 50.4$
Moderate	$60 \leq X < 70$	$31.2 < X \leq 40.8$
Low	$40 \leq X < 60$	$21.6 < X \leq 31.2$
Very low	$0 \leq X < 40$	$X < 21.6$

To test the effectiveness and differences between 2 learning models in creative thinking and math anxiety simultaneously, inferential statistical analysis, namely multivariate variance analysis (Manova) was used. Furthermore, the post hoc effectiveness test of the learning model in terms of creative thinking and math anxiety was used the one-sample t-test. The decision criterion H_0 rejected if the significance value $p < 0.05$.

3. Results

The results of the descriptive analysis of the research conducted to see the difference in the average posttest scores between the problem-posing and scientific learning models in terms of students' creative thinking skills and math anxiety can be seen in Table 3.

Table 3. Description of students' creative thinking and math anxiety

Variable	Creative thinking		Math anxiety	
	Problem posing	Scientific	Problem posing	Scientific
Mean	75.0	74.3	26.6	26.7
Standard Deviation	12.6	12.2	7.0	8.4

Table 3 shows that the students' creative thinking average in the problem-posing and scientific classes reached more than 70 and is included in the high category referring to Table 2. The average and standard deviation of the student's creative thinking in the problem-posing class is higher than in the scientific class. This shows that although the students' creative thinking score in the problem-posing class is higher than in the scientific class, the students' creative thinking in the scientific class is more evenly distributed than in the problem-posing class. Meanwhile, the student's math anxiety score for the problem-posing and scientific classes is less than 31.2 and is included in the low category referring to Table 2. In addition, the average and standard deviation of student's math anxiety in the problem-posing class are lower than in the scientific class. This means that math anxiety in the problem-posing class is more evenly distributed than in the scientific class. The aspects that cause the highest math anxiety in the problem-posing and scientific classes are cognitive and psychology.

Following the descriptive analysis, to determine the effectiveness of the two learning models in terms of creative thinking skills and math anxiety based on the significance of the difference between the scores obtained and the specified criteria, the Manova analysis will be conducted. However, a statistical assumption test needs to be carried out first. The multivariate normality assumption test results with the correlation coefficient for the problem-posing class ($r = .985$, $p = .000$) and the scientific class ($r = .989$, $p = .000$) show that the data is normally distributed multivariate. In the multivariate homogeneity assumption test for both groups with Box-M, the value was 1.790, $F_{(3,882000)} = 0.58$, $p = .629$. Because the normality and homogeneity assumption tests are met, multivariate statistical parametric tests can be conducted. The results of the effectiveness test of the two learning models in terms of creative thinking skills and math anxiety simultaneously can be seen in Table 4.

Table 4. Multivariate test results of effectiveness

Group	T^2 Hotelling	F	Sig.
Problem posing	0.623	10.60	.000
Scientific	0.361	6.14	.000

The results of the Hotelling's Trace multivariate test (Table 4) show that in the class with the problem-posing model ($F_{(2,34)} = 10.60$, $p = .000$) there is a significant difference simultaneously ($p < .05$) between the scores of creative thinking skills ($M = 75.0$) and math anxiety ($M = 26.6$) with the specified criteria. In the class with the scientific model ($F_{(2,34)} = 6.14$, $p = .000$) there is also a significant difference simultaneously ($p < .05$) between the scores of creative thinking ($M = 74.3$) and math anxiety ($M = 26.7$) with the specified criteria. Moreover, the results of the post hoc test with one sample t-test can be seen in Table 5.

Table 5. Univariate test results of effectiveness

Group	Variable	t	Sig.	Mean Different
Problem	Creative thinking	2.39	.022	5.0

posing	Math anxiety	3.97	.000	4.6
Scientific	Creative thinking	2.11	.042	4.3
	Math anxiety	3.19	.002	4.5

The results of the one-sample t-test (Table 5) show that both problem-posing ($t_{(35)}$ = 2.39, p = .022) and scientific ($t_{(35)}$ = 2.11, p = .042) are effective in terms of creative thinking ($p < .05$). In addition, the problem-posing ($t_{(35)}$ = 3.97, p = .000) and scientific ($t_{(35)}$ = 2.39, p = .022) learning models are effective in terms of students' math anxiety ($p < .05$). Both learning models are significantly proven to be effective in students' creative thinking ability and math anxiety, thus analysis of the difference in the effectiveness of the two learning models was carried out.

Table 6. Multivariate test result of effectiveness differences

T^2 Hotelling	F	Sig.
0.001	0.04	.966

The results of the Hotelling's Trace multivariate test (Table 6) showed that there was no significant difference between the problem-posing learning model and scientific ($F_{(2,69)}$ = 0.04, p = .966). The creative thinking (M = 75.0, SD = 12.6) and math anxiety (M = 25.6, SD = 7.0) of the problem-posing class were not significantly different from the creative thinking (M = 74.3, SD = 12.2) and math anxiety (M = 26.7, SD = 8.4) of the scientific class. Thus, the problem-posing learning model is not more effective than the scientific one in terms of students' creative thinking ability and math anxiety. Therefore, further analysis to determine the difference in effectiveness on the dependent variable univariately was not carried out.

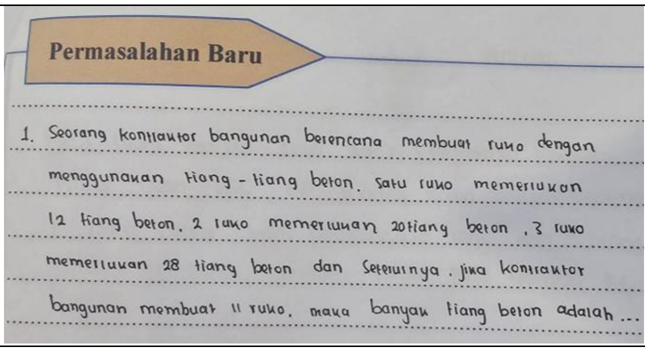
4. Discussion

Based on the descriptive and inferential statistical analysis, the problem-posing and scientific learning models are effective in terms of students' mathematical creative thinking abilities and math anxiety. Students' creative thinking abilities in problem-posing and scientific classes are even included in the high category. Moreover, students' math anxiety in problem-posing and scientific classes is included in the low category. This is in line with the research results of Ghasempour (2021), Miranda dan Mamede (2022), Sadak et al. (2022), dan Sangco et al. (2023) which generalized that the problem-posing learning model is effective in terms of students' creative thinking abilities and math anxiety.

The results of the effectiveness differences analysis using Manova showed no significant differences in effectiveness between the problem-posing and scientific learning models in terms of students' creative thinking skills and math anxiety. The problem-posing and scientific learning models’ activities follow the syntax planned. The implementation of the lesson plan determines the achievement of learning objectives, where if each activity is carried out, the learning objectives can be achieved (Edi & Rosnawati, 2021). In addition, the two models have similarities in encouraging students to actively observe stimuli containing contextual information related to the material being studied, discussing questions related to the information, and drawing conclusions from the process that has been carried out. The difference in problem-posing is on the modify or creating problems from the information provided, while scientific is more about solving problems that have been given.

Students were given stimulus in the form of problems they usually faced in their lives and asked to modify or even to create new problems. To provide a good stimulus which rich in problems to be constructed, teachers must have insight into the broad and meaningful context of mathematics (Liljedahl & Cai, 2021; Rafi & Sugiman, 2019). Presenting a meaningful problem to students can make learning more interactive which is effective in building students' creative thinking skills (Ridwan et al., 2023). In addition, teachers must also facilitate the students how to make mathematics models from the stimulus given as a bridge for students to create new problems in the process (Hartmann et al., 2021).

Problem-posing learning activities are continued by asking questions or problems that show that students have a desire to know through their learning process. The activity of asking questions or asking problems is a mental activity that shows that there is a desire to expand mathematical thinking and a form of dissatisfaction with the knowledge they have (Headrick et al., 2020). In their activities, students discuss with their group members to understand the information in the stimulus and then develop or create a new problem. Students who are involved in problem-posing activities can be creative in viewing and solving problems (Rosli et al., 2014). Students who participate in groups and do not depend on other students tend to have higher creative thinking skills in each indicator compared to students who depend on their group members (Apriliyani et al., 2022).


Permasalahan Baru

1. Seorang kontraktor bangunan berencana membuat ruko dengan menggunakan tiang - tiang beton. satu ruko memerlukan 12 tiang beton, 2 ruko memerlukan 20tiang beton, 3 ruko memerlukan 28 tiang beton dan seterusnya. jika kontraktor bangunan membuat 11 ruko, maka banyak tiang beton adalah ...

Translate:

A building contractor plans to build a shophouse with concrete pillars. To build 1 shophouse need 12 pillars, 2 shophouses need 20 pillars, and 3 shophouses need 28 pillars, and so on. If the building contractor wants to build 11 shophouses, then the number of concrete pillars is....

Figure 1. Example of problem developed by the student

In Figure 1, students can create new problems related to arithmetic sequences according to the context they encounter in life, namely shophouse buildings. To be able to modify or create new problems, creativity is needed both in terms of fluency in understanding information and developing new problems related to the information provided. This is in line with the statement from Voica dan Singer (2012) that there is a strong relationship between problem-posing and students' creative thinking skills. In addition, good literacy or contextual insight possessed by students can help students process existing information and connect it to the learning subject (Amalina et al., 2018). Experience with different insights allows students more flexibility in modifying or creating diverse new problems (Guo et al., 2020). Conversely, students with low contextual insight can modify problems, but sometimes aren't related to the concept, cannot be solved, or aren't relevant (Cai et al., 2015).

Students with good problem-posing skills are also creative students in solving problems (Cai et al., 2015). Creative thinking skills are also related to students' conceptual understanding where understanding the concept of the discovery process requires creativity in exploring (Komarudin et al., 2023). Creative thinking processes enable students to investigate alternative strategies, design and construct new solutions to a problem (Robson, 2014). One example of a student with high creative thinking skills in solving problems can be seen in Figure 2.

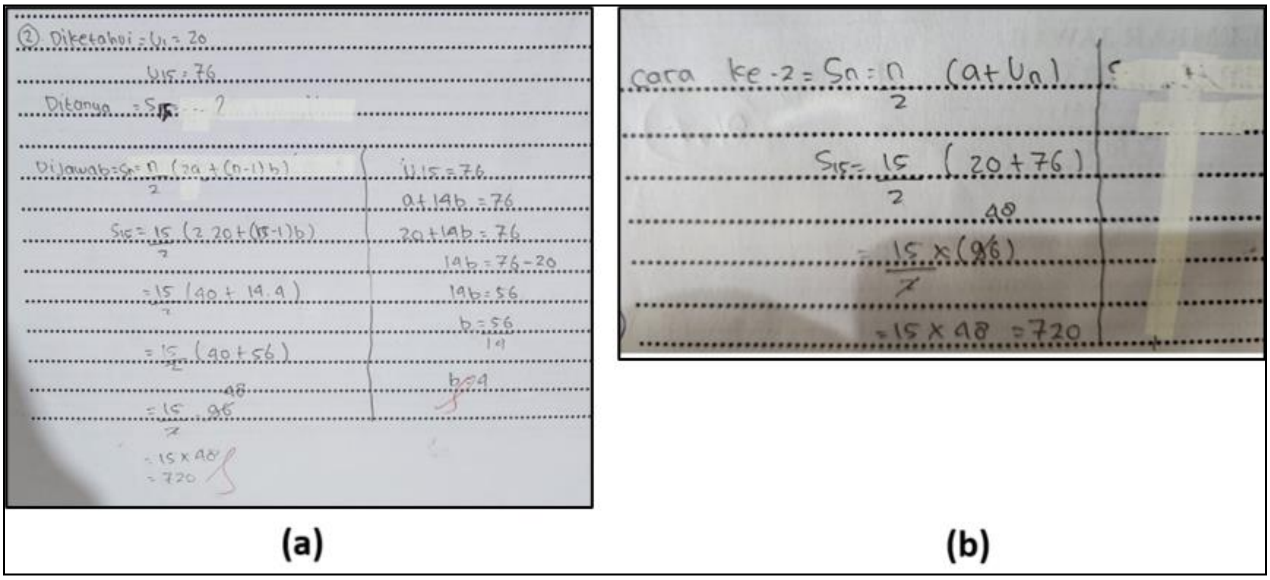


Figure 2. Example of students' creativity in solving problem

Based on Figure 2, students can solve problems related to arithmetic series in 2 different ways. The first method (2a) is shown by finding the difference between terms before determining the sum of the arithmetic series. In the second method (2b) students directly determine the sum of the arithmetic series without determining the difference value. Students are proven to be able to fluently solve problems in 2 different ways. The student's creative thinking abilities are manifested in the abstraction-generalization process to achieve synthesis and simplification (Singer & Voica, 2015). The integration of the steps in problem-posing activities into school mathematics learning can foster students' creative thinking abilities (Bicer et al., 2020). Meanwhile, students' math anxiety in problem-posing classes and scientific classes is included in the low category. This is in line with Brown dan Walter (2005) that stated feelings of stress or anxiety in learning mathematics (math anxiety) can be overcome by using the problem-posing approach. The experiences experienced by students in learning mathematics can affect students' math anxiety (Hunt & Maloney, 2022). In problem-posing learning, students are formed into groups with 3-4 members. The ideal number of group members can make discussions run more optimally and allow each member to participate more and not depend on other group members (Cahirati et al., 2020). In addition, with a smaller number of members, the impact of social loafing can be minimized, namely decreased motivation and effort from someone in the group due to the presence of other members (Retnowati & Aqiilah, 2017).

In this study, the main factors that cause students to experience math anxiety are from the cognitive aspect, namely the fear of being unable to answer tests or exercises because they are difficult or understand the material. The results of this study are similar to the results of OECD (2013) that 31% of students from 34 participating countries feel tense when working on math problems. Students who do not understand the material are afraid of making mistakes when working on questions (Rismayana et al., 2021). The fear of not being able to answer questions can have an impact on the learning outcomes that will be obtained (Munggaran et al., 2022). If students have a perception of difficulties in understanding the material, it might affect students to not be able to understand the material properly (Öztürk et al., 2020). Other factors that causing math anxiety that were not identified in this study are embarrassing incidents, bad experiences in learning mathematics, social pressure and expectations, and myths about mathematics (Arem, 2003).

Math anxiety has a negative impact on students in learning mathematics. Math anxiety can result in mathematics learning objectives not being achieved because it makes students' performance low, hence the achievement of the student's learning process is not optimal (Núñez-Peña et al., 2013). Math anxiety can hinder students' ability to reach their potential in terms of learning experiences and mathematics assessments in the classroom, both as an emotional response and as an object of fear or worry (Ramirez et al., 2016). Likewise, students who have higher math anxiety tend to achieve lower achievement than students with low math anxiety (Guo et al., 2020; Radišić et al., 2015). In addition, math anxiety also affects students' mathematical creative thinking abilities, especially in the problem-solving process(Fetterly, 2020; Umi et al., 2015). Sharma (2014) concluded that math anxiety is a crucial factor in the success of learning strategies to improve students' creative thinking abilities.

In order to reduce students' math anxiety, there are various ways that teachers can implement it. Teachers can organize the learning material that does not exceed the students' load, thus affecting the level of understanding of the material (Chen et al., 2018). Teachers can also motivate students to focus on their successes and abilities rather than failures and explain the usefulness of mathematics in various fields that students like (Blazer, 2011). This can be done by encouraging students to tell their experiences in the form of problems through problem posing according to the material being studied. Providing relaxation and humour in the middle of learning can be done to relieve student anxiety (Furner & Gonzalez-DeHass, 2011).

Problem-posing can be used as a strategy to involve students' experiences in learning to overcome math anxiety and foster creative thinking skills. Problem-posing can be used as a bridge for contextual learning because when outside the classroom, students more often identify and define mathematical problems that they find in their way (Ormrod et al., 2017). Problem-posing learning can start by creating problems that can be reconstructed with various possibilities by students and through illustrations so that students have an idea (Triwibowo et al., 2017). The addition of instructions to create problems that can be solved in more than 1 way (open-ended) can also be done to hone students' flexibility and novelty skills or prioritize the semi-structured problem-posing model (Bonotto & Santo, 2015). Instructions can be made as clear as possible by considering time, hence students did not misinterpret or have difficulty understanding and carrying out the instructions (Landas & Alova, 2022). Students are given more opportunities to explore new possibilities of problems (Crespo & Sinclair, 2008). Problem posing can also be integrated with instructions to create problems based on higher-order thinking skills that have various ways and answers.

5. Conclusion

Based on the results and discussion, it can be concluded that the problem-posing learning model is effective in terms of student's creative thinking skills and math anxiety simultaneously. The scientific learning model is simultaneously effective for students' creative thinking skills and math anxiety. Further analysis shows no significant difference in effectiveness between problem posing and scientific in terms of students' creative thinking skills and math anxiety. This study has limitations where it did not analyze the relationship between the level of math anxiety and the level of students' creative thinking in mathematics learning as well as did not analyze the factors that cause math anxiety in mathematics learning based on students' descriptions. Following up on the conclusions of this study, there are opportunities for further research that can be carried out, namely analyzing the relationship between the level of math anxiety and students' creative thinking skills in solving open-ended problems based on higher-order thinking skills.

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