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AN EXAMINATION OF SIXTH-GRADE STUDENTS' PROBLEM POSING SKILLS AND THEIR SELF-EFFICACY BELIEFS IN PROBLEM POSING*

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Abstract: This study examines the relationship between sixth-grade students' problem-posing skills and their self-efficacy beliefs in problem posing. The research was conducted with 30 sixth-grade students studying at a middle school in the Western Black Sea Region during the 2023–2024 academic year. Data were collected through a Problem Posing Test and the "Problem Posing Self-Efficacy Scale." The results revealed a moderate and significant relationship between students' problem posing skills and problem posing self-efficacy beliefs ($R^2 = 0.32$). Regression analysis indicated that self-efficacy beliefs significantly predicted students' problem-posing performance. It was also observed that students mostly posed routine and realistic problems. The findings suggest that problem posing activities should be integrated more extensively into mathematics curricula and that supportive feedback from teachers is essential for enhancing students' self-efficacy in this area.

Keywords: Problem posing, problem posing self-efficacy, mathematics education, sixth grade, regression analysis

1. Introduction

The globalization of the economy and rapid developments in communication technologies have reshaped how individuals live, work, and learn (Voogt & Roblin, 2012). These changes have influenced educational practices, highlighting the need to develop problem solving skills. Mathematics education plays a central role in fostering students' creative thinking and problem solving abilities (Khalid et al., 2020). As a key 21st-century skill (PISA, 2021), problem solving is essential for understanding mathematics (Dede & Yaman, 2005). However, practical mathematical thinking also requires the ability to pose problems, which complements the process of solving them.

Problem posing involves similar cognitive processes to problem solving (Kırnap Dönmez, 2014). It encourages students to examine mathematical concepts from different perspectives, deepening their understanding (Turhan & Güven, 2014). Moreover, it helps learners relate mathematics to real-life situations and make sense of abstract ideas (Özer et al., 2020).

In many countries' mathematics curricula, problem posing is considered an integral component of problem solving and is often used to assess students' mathematical understanding. It refers to the ability to generate new problems from given situations, enhancing conceptual understanding and application skills (Wang et al., 2022). Silver (1994) defines it as reforming an existing problem or creating a new one based on a given context, while Grundmeier (2003) highlights its role in developing mathematical thinking.

Problem posing supports flexible thinking, encourages connections between mathematics and daily life, and fosters the use of symbolic representations (Bayazit & Kırnap Dönmez, 2017; Tekin Sitrava & Işık, 2018). Kılıç (2023) classifies problem posing by structural features, cognitive processes, and

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their relation to problem solving. This study focuses only on structurally based types, as defined by Stoyanova and Ellerton (1996), shown in Table 1.

Table 1. *Types of problem posing based on structural features (Stoyanova & Ellerton, 1996)*

Problem Posing Situations	Definition	Educational Contribution
Free	Problems generated without constraints	Encourages creativity and flexible thinking
Semi-structured	Problems based on open-ended situations	Balances creativity with prior knowledge
Structured	Problems derived from existing problem structures	Enhances focus on specific concepts

Problem posing is also linked to students' self-efficacy beliefs, influencing their engagement and performance (Özgen & Bayram, 2019). Research indicates that problem posing activities, especially those designed with real-life contexts, improve students' achievement and problem solving abilities (Mahendra & Slamet, 2017; Geçici & Aydın, 2019).

Rooted in Bandura's social cognitive theory, self-efficacy refers to belief in one's ability to succeed in a given task (Yarar et al., 2020; Kutluca & Aydın, 2016). In mathematics, self-efficacy in problem posing reflects students' confidence in generating meaningful mathematical problems. High self-efficacy is associated with greater creativity and persistence (Çelik & Arslan, 2022; Günhan et al., 2019).

Problem posing contributes not only to mathematical understanding but also to reasoning, communication, and confidence (Kar & Işık, 2014; Erdoğan & Erben, 2018). It allows learners to explore mathematics more deeply, moving beyond solutions to questioning and constructing problems themselves.

1.1. Research Aim and Questions

This study investigates the relationship between sixth-grade students' problem-posing skills and their self-efficacy beliefs regarding problem posing. The research questions are:

1) What are the problem posing skills of sixth-grade students?
2) Is there a significant relationship between sixth-grade students' problem-posing skills and their problem posing self-efficacy beliefs?

2. Method

2.1. Research Design

This study examines the relationship between sixth-grade students' problem posing skills and their problem posing self-efficacy beliefs related to these skills. A descriptive survey design was adopted. This design is widely used in social sciences and enables the identification of existing conditions within a specific timeframe (Creswell, 2017). It provides a suitable framework to systematically analyze participants' opinions, attitudes, and behaviors regarding a particular topic.

2.2. Participants

The study sample consisted of 30 sixth-grade students attending a private middle school in the Western Black Sea region of Turkey during the fall semester of the 2023–2024 academic year. Due to the research being conducted in the researcher's classroom, a convenience sampling method was employed. This method is commonly used when the researcher has easy access to a specific group (Yıldırım & Şimşek, 2016). They were assigned codes ranging from P1 to P30 to protect students' privacy. Additionally, this study draws on pilot data from one of the researchers' doctoral dissertations.

2.3. Data Collection Tools

Two tools were used to collect data: the Problem Posing Test (PPT) developed by the researchers and the Problem Posing Self-Efficacy Scale developed by Özgen and Bayram (2019).

The PPT consists of four questions. Questions 1 and 2 each include two parts (a and b). While part (a) of these questions involves structured problem posing tasks, part (b) and the last two questions (3-4) include semi-structured problem posing tasks. The PPT's pilot implementation was carried out before the main study. Two faculty members and two mathematics teachers reviewed and evaluated the items for content validity. The Kolmogorov–Smirnov test indicated a p-value of .083. Since the p-value was greater than .05, the data were considered to be normally distributed.

Cronbach's alpha coefficient was calculated and found to be .696 to assess the reliability of the PPT. According to Can (2017), this value falls within the acceptable reliability range of $.60 \leq \alpha \leq .90$, indicating that the test is considered reasonably reliable. The structure of the PPT is presented in Table 2.

Table 2. *Problem Posing Test*

1. a. Mr. Ahmet spent 1/5 of his salary on rent and 3/10 on household expenses. After these payments, he realized he had 5,250 TL left. → Based on the given information, pose and solve at least one problem. (You may not change the given data, but add new information if necessary.) b. Mr. Ahmet spent some of his salary on rent and household expenses. Afterwards, he noticed how much money he had left. → Based on the given information, pose at least one problem and solve it using your numerical values. (You may not change the given data.) 2. a. After leaving the school, the bus drops off half of the students at each stop. After three stops, the driver notices that only three students remain on the bus. (No new students board the bus after it departs from school.) → Based on the given information, pose and solve at least one problem. (You may not change the given data, but add new information if necessary.) b. After leaving the school, the bus drops off some students at each stop. Afterwards, the driver checks how many students remain on the bus. → Based on the given information, pose at least one problem and solve it using your numerical values. (You may not change the given data.) 3. Draw a shape and pose a problem that cannot be solved without using this shape, then solve the problem. 4. Create a problem that involves both addition and multiplication operations. What would it be? Pose and solve the problem.

The Problem Posing Self-Efficacy Scale, developed by Özgen and Bayram (2019), is a valid and reliable instrument to assess middle school students' self-efficacy beliefs regarding problem posing. The scale consists of 24 items (17 positive and seven negative statements) and is structured under five subdimensions. It is a 5-point Likert-type scale ranging from strongly disagree (1) to strongly agree (5). Total scores range from 24 to 120, with higher scores indicating stronger self-efficacy beliefs in problem posing. The scale's internal consistency is considered high, with a reported Cronbach's alpha coefficient of 0.85.

2.4. Data Collection and Analysis

The data for this study were collected during the fall semester of the 2023–2024 academic year. Students were given two class hours to complete the Problem Posing Test (PPT). Immediately following this session, the Problem Posing Self-Efficacy Scale was administered. All research procedures adhered to ethical guidelines, and ethical approval was obtained from the Bartın Provincial Directorate of National Education (Approval No: E-64441482-605.01-92816853, dated 25.12.2023).

Data were analyzed using the Statistical Package for the Social Sciences (SPSS-28). To analyze students' problem-posing performance, a set of evaluation criteria was developed by integrating and adapting the frameworks proposed by Silver and Cai (1996) and Cankoy and Özder (2017). The revised criteria and their descriptions are presented in Table 3.

Table 3. *Problem Posing Evaluation Criteria (Adapted from Silver & Cai, 1996; Cankoy & Özder, 2017)*

Category	Subcategory	Criteria	Score
Mathematical Problems	Solvability	Solvable / Not solvable	1 / 0
	Plausibility	Plausible / Implausible	1 / 0
	Structure	Unknown at start (algebraic) / at end (arithmetic)	1 / 0
	Context	Non-routine / Routine	1 / 0
Language Use	Clarity	Clear / Not clear	1 / 0
	Grammar	Correct / Incorrect	1 / 0
Problem Content	Appropriateness →	Appropriate / Not appropriate	1 / 0
Other	Non-mathematical or non-statement	No math or no meaningful sentence	0

The maximum total score from the problem posing test was 42, with each item scored on a scale from 0 (lowest) to 7 (highest). The researchers evaluated participants' responses. Inter-rater reliability was calculated using the formula proposed by Miles and Huberman (1994) and was found to be 0.87. Any discrepancies between the scorers were resolved through discussion and consensus. A regression analysis was conducted to examine the relationship between students' problem posing performance and their self-efficacy beliefs. This statistical method was used to determine the extent to which the dependent variable (problem posing performance) could be predicted by the independent variable (problem posing self-efficacy beliefs) (Can, 2017).

3. Finding

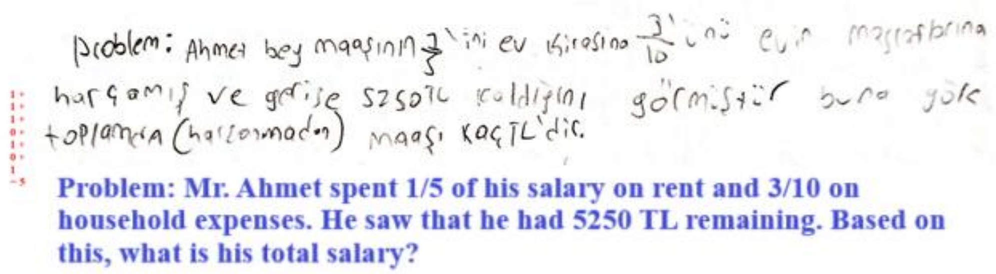
The relationship between sixth-grade students' responses to the problem posing tasks and their scores on the Problem Posing Self-Efficacy Scale was examined. Descriptive statistics regarding students' responses to the problem posing test are presented in Table 4.

Table 4. *Descriptive Statistics of the Problem Posing Test*

Statistic	Value
N	30
Mean	24.87
Median	25.00
Mode	25.00*
Standard Deviation	5.86
Minimum	14.00
Maximum	33.00

*Note: There are multiple modes; the smallest value is reported.

As shown in Table 4, students' scores on the problem posing test ranged from 14 to 33 out of a possible maximum of 42 points. The average score was calculated as 24.87. An analysis of the most frequently obtained scores revealed that the values 25, 28, 31, and 33 were repeated three times; the smallest of these, 25, is reported as the mode. The median score was also 25, and the standard deviation was 5.86. While the highest possible score on the test is 42, the highest score observed among sixth-grade students was 33. One student's response per item is presented below to illustrate further sixth-grade students' problem posing performances. The examples were selected to reflect variations in both problem posing performance scores and problem posing self-efficacy beliefs. Figure 1 presents student P21's response to item 1a of the problem posing test.

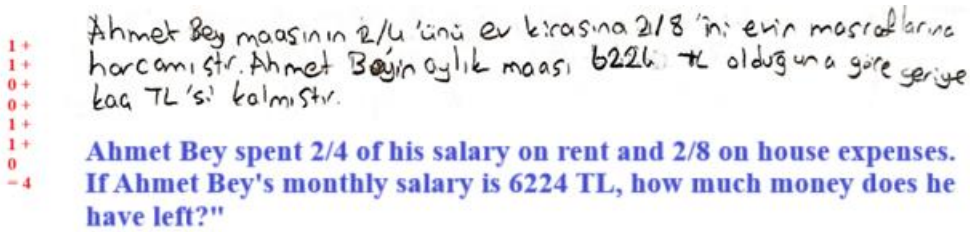

problem: Ahmet bey maaşının 1/5'ini ev kirasına 3/10'unu evin masraflarına harcamış ve geriye 5250TL kaldığını görmüştür buna göre toplamda (harcamadan) maaşı kaç TL'dir.

Problem: Mr. Ahmet spent 1/5 of his salary on rent and 3/10 on household expenses. He saw that he had 5250 TL remaining. Based on this, what is his total salary?

Figure 1. *P21's Response to Item 1a of the Problem Posing Test*

Figure 1 presents the problem posed by student P21 and the corresponding scores the researchers assigned. Responses that qualified as mathematical problems were scored based on the criteria outlined in Table 3. The figure shows that P21 received one point each for posing a solvable, realistic, and unknown-start problem. However, because the problem aligned with standard classroom practices and did not require novel strategies, it was classified as routine and scored zero in that category. P21 earned one additional point for using clear and coherent language, but received zero in grammar due to minor punctuation errors (e.g., the problem ends with a period instead of a question mark). Lastly, since the posed problem was directly related to the given information, P21 received another point. The student scored five out of a possible seven points for this particular problem.

Considering that seven is the highest possible score for a single problem, a score of five indicates a relatively strong performance. P21 earned 28 points on the problem posing test and 105 points on the problem posing self-efficacy scale. These results suggest that P21 is a capable problem poser with a high level of problem posing self-efficacy. The problem posed by student P17 in response to item 1b is shown in Figure 2.


1+
1+
0+
0+
1+
1+
0
=4

Ahmet Bey maaşının 2/4'ünü ev kirasına 2/8'ini evin masraflarına harcamıştır. Ahmet Bey'in aylık maaşı 6224 TL olduğuna göre geriye kaç TL'si kalmıştır.

Ahmet Bey spent 2/4 of his salary on rent and 2/8 on house expenses. If Ahmet Bey's monthly salary is 6224 TL, how much money does he have left?"

Figure 2. *P17's Response to Item 1b of the Problem Posing Test*

As seen in Figure 2, P17 constructed a solvable and reasonable problem. However, the problem does not fully comply with the given problem posing instructions. Based on the researchers' evaluation, two out of the four points awarded to P17 were due to adherence to grammar and writing conventions. Although the student did not use a question mark at the end of the sentence, a point was granted considering the overall attention to punctuation, capitalization, and apostrophes. Despite being solvable, the problem lacks contextual relevance, mathematical structure, and alignment with the instructions. This indicates certain deficiencies in P17's performance on this specific problem posing item. Nonetheless, P17's total score of 31 on the problem posing test and 89 on the problem posing self-efficacy scale suggests that the student possesses a fair level of problem posing ability and confidence in this area.

Additionally, P2 left item "a" of the second question blank. This suggests that the student may not have fully understood the instructions in the problem posing test or lacked sufficient motivation to engage in the problem construction process. This conclusion was reached through an unstructured interview conducted with the student after the administration of the PPT. Since no response was provided for this item in the PPT, it was evaluated as zero points. Nevertheless, P2 received 21 points on the problem posing test and 78 points on the problem posing self-efficacy scale. These results indicate that, although P2 could pose problems, the student received a low score and had a relatively low problem posing self-efficacy belief in this domain. It can also be inferred that the student requires support in the problem posing process, and that implementing appropriate strategies is essential for developing these skills. The problem posed by P28 for item "b" of the second question in the problem posing test is presented in Figure 3.

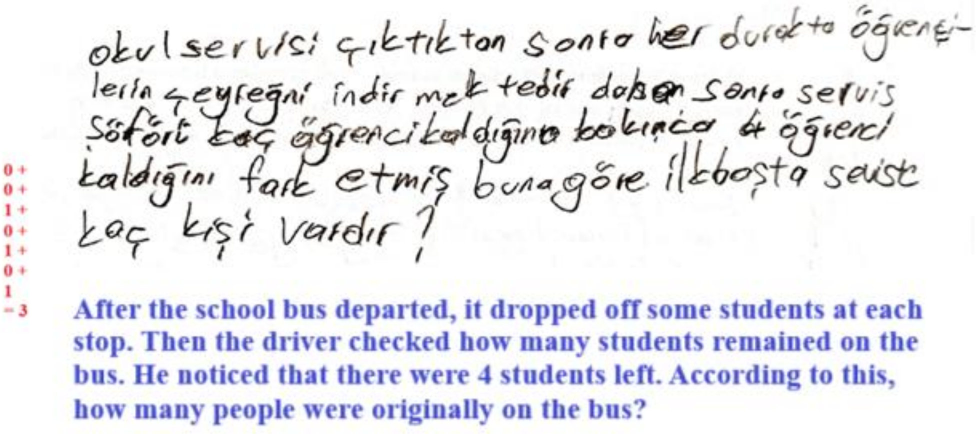


Figure 3. *P28's Response to Item 2b of the Problem Posing Test*

As shown in Figure 3, P28 did not indicate how many stops the students were dropped off at. Due to this omission, the constructed problem was evaluated as neither solvable nor plausible. However, the student formulated a problem with an unknown starting value and articulated it clearly, which was considered a strength. Based on these criteria, the student received three points for this item. P28 obtained 26 points from the problem posing test and scored 73 on the problem posing self-efficacy scale. This result suggests that P28 possesses a moderate level of problem posing competency but a relatively low level of problem posing self-efficacy. Problem posing self-efficacy refers to individuals' beliefs in their capabilities to successfully perform a given task, and it directly influences students' motivation, attitudes, and academic achievement. P28's low motivation during the problem posing process likely led to an oversight regarding the number of stops. The problem posed by P18 in response to item 3 of the problem posing test is presented in Figure 4.

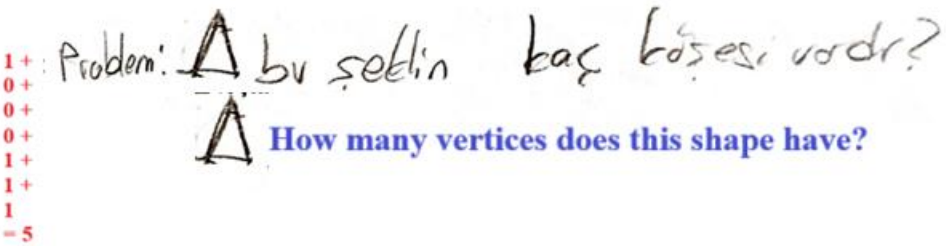


Figure 4. *P18's Response to Item 3 of the Problem Posing Test*

As shown in Figure 4, although P18 is a sixth-grade student, when asked to construct a problem based on a given shape, they preferred to formulate a question more appropriate for a lower grade level. Since the question could be solved by examining the shape, it was evaluated as solvable. However, due to its suitability for younger grade levels, the problem was not plausible and categorized as a routine problem. Because the response was brief and free from grammatical or spelling errors, one point was awarded for both language accuracy and adherence to writing conventions. Additionally, one more point was granted for complying with the problem posing guidelines, resulting in a score of five points for this item.

No distinction was made between the difficulty levels of the posed problems, as such evaluations can be subjective and vary according to individual student characteristics. P18 scored 25 points on the problem posing test and 98 points on the problem posing self-efficacy scale. The problem constructed by P11 for the fourth item of the problem posing test is presented in Figure 5.

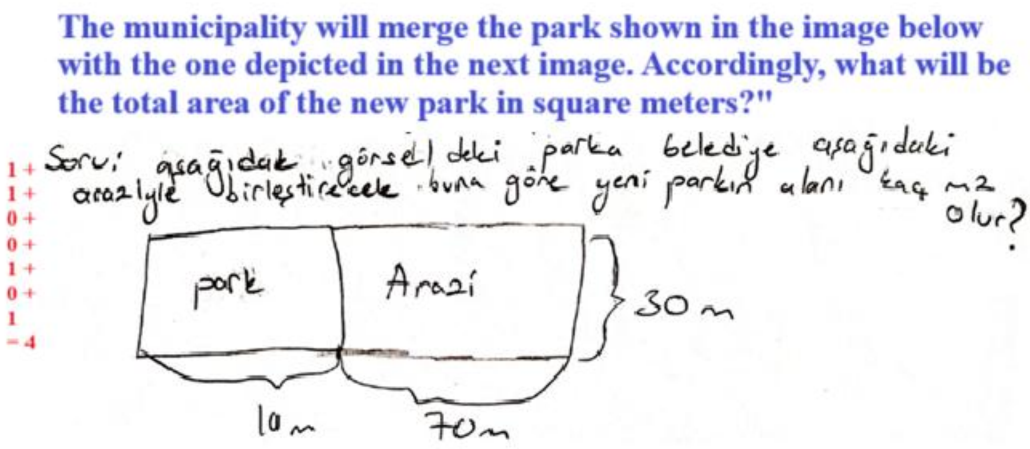


Figure 5. ***P11's Response to Item 4 of the Problem Posing Test***

It was evaluated as appropriate, as P11 constructed a problem that could be solved using addition and multiplication operations. The problem was considered both solvable and plausible. Additionally, since P11 included a visual representation to enhance clarity, the problem was evaluated as open-ended. Given that the problem resembled those commonly encountered in classroom settings, it was categorized as a routine problem. However, due to the unknown being placed at the end of the question, zero points were assigned for that specific criterion. P11 received 31 points from the problem posing test, which is considered a high score. Furthermore, a score of 98 obtained from the problem posing self-efficacy scale indicates a high level of perceived problem posing self-efficacy.

A simple linear regression analysis was conducted to determine whether sixth-grade students' problem-posing self-efficacy beliefs regarding problem posing significantly affect their actual problem-posing performance. Before this, the Shapiro-Wilk test assessed whether the data followed a normal distribution. Based on the results of this test, the p-value for the problem posing test was found to be 0.115, and the p-value for the problem posing self-efficacy scale was 0.322. These findings indicate that the data were normally distributed. Descriptive statistics regarding sixth-grade students' problem-posing self-efficacy beliefs toward problem posing are presented in Table 5.

Table 5. *Descriptive Statistics of Sixth-Grade Students' Self-Efficacy Beliefs Toward Problem Posing*

n	Min.	Max.	$\bar{X}$	SS.
30	73	115	90,9	10,259

It was found that the participants obtained an average score of 90.9 out of a total of 120 on the Problem Posing Self-Efficacy Scale. The results of the regression analysis examining the relationship between sixth-grade students' problem posing skills and their problem posing self-efficacy beliefs toward problem posing are presented in Table 6.

Table 6. *Regression Analysis of the Relationship Between Students' Problem Posing and Their Self-Efficacy Beliefs*

Variable	B	SE	%95 CI		*t*	*p*
			LL	*UL*		
Static	-4,720	8,122	-21,356	11,917	-,581	,566
PPT	,325	0,089	,144	,507	3,665	,001
R= ,569, R^2 =,324						

According to the regression analysis results, a moderate relationship was identified between the participants' problem posing self-efficacy beliefs regarding problem posing and their actual problem posing skills. The correlation coefficient was 0.30 to 0.70 (R = 0.569, R^2 = 0.325). The equation representing the relationship between problem posing self-efficacy beliefs (y) and problem posing performance (x) was calculated as:

$y = -4.720 + 0.325x$

This analysis further revealed a moderate, negative, and statistically significant relationship between the participants' problem posing skills and their problem posing self-efficacy beliefs. The data indicate that approximately 32% of the variance in problem posing scores can be explained by the participants' problem posing self-efficacy beliefs. The regression analysis also showed that the model was statistically significant ($F = 13.734$; $p = 0.001$), and the R^2 value reflects the model's generalizability by indicating that 32% of the total variance is explained.

4. Discussion and Conclusion

This study explored the relationship between sixth-grade students' problem posing skills and their problem posing self-efficacy beliefs. In line with this aim, students' performances were analyzed using a descriptive approach. In mathematics education, problem posing is critical in fostering analytical thinking, creative problem solving, and deep conceptual understanding. In parallel, problem-posing self-efficacy beliefs influence academic motivation and students' capacity to deal with challenges in learning processes. Therefore, examining the relationship between students' problem-posing skills and their problem-posing self-efficacy beliefs provides valuable insights for developing mathematics curricula and improving instructional practices.

The findings revealed that students were generally able to pose solvable problems. These problems often resembled familiar question types, indicating a routine and realistic problem-construction tendency. Most students paid attention to grammar and spelling rules and were able to formulate problems according to the given instructions. While some students created developmentally appropriate tasks, others opted for simpler structures, possibly reflecting differences in perceived difficulty or confidence levels. This observation is aligned with literature reporting that many sixth-grade students can pose viable but often routine problems.

Regression analysis indicated a positive association between students' problem-posing self-efficacy beliefs and their problem-posing skills. While this relationship supports theoretical expectations, the strength of the association suggests that additional factors, such as cognitive flexibility, prior experiences with open-ended tasks, or the quality of instruction, may also contribute meaningfully to students' problem-posing performance. Indeed, metacognitive awareness and creative thinking have been emphasized in the literature as essential components of successful problem posing, and these may not be fully reflected in problem-posing self-efficacy scores alone.

Previous studies have documented students' challenges in generating meaningful and coherent problem statements. Similar patterns were observed in this study, with some students producing incomplete or less original tasks. Despite these limitations, many students demonstrated the ability to construct mathematically sound and instructionally relevant problems, reflecting their operational knowledge and the instructional support they received.

Based on the findings, it is recommended that mathematics curricula incorporate more opportunities for structured and open-ended problem posing activities. Teachers should provide ongoing feedback to build students' confidence and help refine their problem posing approaches. Furthermore, teacher education programs should include training on implementing problem posing tasks in the classroom. Longitudinal studies tracking the development of students' problem-posing skills and problem-posing self-efficacy beliefs could offer deeper insights into the growth and interaction of these competencies over time.

It is important to note that this study was conducted with a limited sample. Future research should involve larger and more diverse student groups to enhance generalizability. Comparative studies across different grade levels and educational contexts would contribute to a broader understanding of the dynamics between problem posing performance and problem posing self-efficacy beliefs.

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