

The Relationship between Secondary School Students' Problem-Posing Self-Efficacy Skills and The Perspective of Their Problem-Solving Attitudes¹

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Research article

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Abstract

The study examined the relationship between the problem-solving attitudes of secondary school students and problem-posing self-efficacy. For this reason, this research study was conducted using the correlational research model. The research study group consisted of 223 students selected from 5th, 6th, 7th, and 8th-grade students, 66 of whom are private and 163 of whom are studying in public secondary schools in Istanbul. The research data were gathered using demographic information form, math problem-solving attitude scale, Mathematics Problem Solving Attitude Scale (MPSAS), and Problem Posing Self-Efficacy Scale (PPSES). The study's data was analyzed using the Kolmogorov-Smirnov test, t-test, one-way analysis of variance (ANOVA) correlation, and regression analyses. Based on the analysis, it was concluded that a significant relationship exists between secondary school students' MPSAS and PPSES. It is seen that this relationship is a highly significant positive relationship. Simple regression analysis was performed because of the correlation. It was concluded that the total scores obtained from the MPSAS significantly predicted the total scores of the PPSES. It is seen that the problem-solving attitude scale positively affects the problem-posing self-efficacy scale and explains 46% of the total variance in the problem-posing self-efficacy scale.

Keywords: Mathematics education, secondary school mathematics, secondary school students, problem-solving attitude, problem-posing self-efficacy.

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Ortaokul Öğrencilerinin Problem Kurma Öz Yeterlik Becerileri ile Problem Çözme Tutumlarına Bakış Açıları Arasındaki İlişki⁶

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Araştırma Makalesi

Geliş Tarihi:.....

Kabul Tarihi:.....

Öz

Araştırmada ortaokul öğrencilerinin problem çözme tutumları ile problem kurma özyeterlikleri arasındaki ilişki incelenmiştir. Bu nedenle bu araştırma, ilişkisel araştırma modeliyle gerçekleştirilmiştir. Araştırmanın çalışma grubunu İstanbul'da bulunan resmi ortaokullarda öğrenim gören 66'sı özel ve 163'ü olmak üzere 5, 6, 7 ve 8. sınıf öğrencileri arasından seçilen 223 öğrenci oluşturmuştur. Araştırma verileri demografik bilgi formu, matematik problemi çözme tutum ölçeği, Matematik Problemi Çözme Tutum Ölçeği (MPSAS) ve Problem Kurma Öz-Yeterlik Ölçeği (PPSES) kullanılarak toplanmıştır. Araştırmada verilere Kolmogorov-Smirnov testi, t-testi, tek yönlü varyans analizi (ANOVA), korelasyon ve regresyon testleri uygulanmıştır. Analiz sonucuna göre mevcut ortaokul öğrencilerinin MPSAS'ları ile PPSES'leri arasında anlamlı bir ilişki olduğu sonucuna varılmıştır. Bu ilişkinin oldukça anlamlı pozitif bir ilişki olduğu görülmektedir. Korelasyon nedeniyle basit regresyon analizi yapıldı. MPSAS'tan elde edilen toplam puanların, PPSES toplam puanlarını anlamlı düzeyde yordadığı sonucuna varılmıştır. Problem çözme tutum ölçeğinin, problem kurma öz yeterliliği ölçeğini olumlu yönde etkilediği ve problem kurma öz yeterliliği ölçeğindeki toplam varyansın % 46'sını açıkladığı görülmektedir.

Anahtar Sözcükler: Matematik eğitimi, ortaokul matematiği, ortaokul öğrencileri, problem çözme tutumu, problem kurma özyeterliliği.

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Introduction

Mathematics teaching is one of the pioneering fields among other courses. Mathematics is a branch of science that examines the properties of these concepts and the relationships between them based on abstract concepts such as numbers, geometric shapes, function, and space (Altun, 2008). In other words, mathematics includes reaching new information using existing data and making new inferences from the information obtained (Baykul, 2009). Some skills are suggested for the maturation of mathematical knowledge. Problem-solving is one of these skills (Silver, 1987). Due to this importance, problem-solving is especially emphasized in the curriculum (National Council of Teachers of Mathematics [NCTM], 2000; Ministry of National Education [MONE], 2018). In addition, in the renewed curriculum, it is crucial not to memorize and transfer the knowledge but to reveal it by making sense (MONE, 2018). People must keep up with the changes and developments in the curriculum due to the rapidly developing world of science and technology. Reasoning, creativity, problem-solving, and problem-posing skills are critical in these change and development processes. Mathematics education is an essential element in forming these skills in individuals. (NTCM, 1987). Both problem-solving and problem-posing are considered the skills to be acquired by students in mathematics education in recent years in our country (MONE, 2018).

Problem-solving refers to the individual's ability to find different solutions beyond the simple application of the rules that people have learned with the help of their experiences in solving a problem (İlhan et al., 2021). Problem-posing occurs when an existing problem is arranged, or new problems are created (Silver, 1994). It is stated that the most important factor affecting students' problem-solving skills is problem-posing (Grundmeier, 2003). Because it is seen that these two skills complement each other and are related (Cai, 2003; Ellerton, 1986; Zhang et al., 2022). By reviewing the literature, it becomes clear that the effect of problem-solving skills on problem-solving skills can be expressed under three main headings:

- I. The problem-solving process shows where and how to start problem-solving (Erkan & Kar, 2022; Xie & Masingila, 2017).
- II. The problem-solving skill applied during problem-posing gives information about whether the problem-posing is done correctly or not (Xie & Masingila, 2017).
- III. Problem-solving after the problem-posing process makes existing ideas about the mathematical problem more detailed (Erkan & Kar, 2022; Xie & Masingila, 2017).

As stated above, it is also possible to solve problems while posing them, which is known as problem-posing in the problem-solving process. In this context, it can be said that problem-solving and problem-posing skills constitute the basic building blocks of mathematical thinking and mathematics education (Silver, 1997). Problem-posing and problem-solving approaches are indispensable to mathematics teaching activities in schools because they improve individuals' high-level thinking abilities and increase their academic potential (Akay, 2006).

Cognitive and affective domain features that affect problem-solving and problem-posing skills, indispensable parts of mathematics teaching activities, can be mentioned. Affective domain characteristics should be considered as much as cognitive domain features. Desired goals cannot be fully achieved if the necessary importance is not given to the characteristics of the affective domain (Gömlüksiz & Kan, 2012). Because not only the cognitive domain but also the affective domain should be considered in mathematics teaching (Çalışkan, 2014). Affective domain features include interest, value, attitude, motivation, self-efficacy, belief, and emotions (Gökcalp, 2021, p.185). It can be said that the most important of

these factors are students' self-efficacy perceptions and attitudes toward the mathematics lesson (Ayan, 2014). Students' self-efficacy perceptions towards mathematics have a decisive effect on their mathematics performance (Kurtuluş & Öztürk, 2017). In mathematics education, it is accepted that students with a high level of mathematical self-efficacy perception focus their attention more precisely during the lesson and are therefore successful (Öztürk & Şahin, 2015). Many studies on mathematics self-efficacy perception show that mathematics self-efficacy perception is a significant factor in mathematics education (Çelik, 2022; Geçici & Aydın, 2019; Kurtuluş & Öztürk, 2017; Özgen & Bayram, 2019; Sevgi & Çalışkan, 2020; Şengül & Gülbağcı, 2013; Ural, 2015; Usher, 2009; Ünlü, 2021). Similarly, students' attitudes towards mathematics also affect their mathematical performance (Çanakçı & Özdemir, 2011). Students' positive attitudes towards mathematics contribute significantly to their learning of mathematics (MoNE, 2018). It has been stated in many studies in the field that students' attitudes towards mathematics contribute positively to their learning of mathematics (Çanakçı & Özdemir, 2011; Doruk et al., 2016; Tan, 2015; Taş, 2018; Tat, 2021).

Students' attitudes toward mathematics are essential in mathematics education (Tat, 2021, p.112). Attitude toward mathematics is the particular purpose of the mathematics curriculum at primary and secondary schools, and it is stated that "by developing a positive attitude towards mathematics with their experiences in learning mathematics, they will develop a self-confident approach to mathematical problems" (MONE, 2018, p.9). In other words, students' mathematical attitudes affect their desire to learn or not to learn mathematics (Taş, 2018). Students' success in mathematics lessons or solving mathematical problems cannot be explained only by their knowledge level. Their beliefs and attitudes should also be taken into account in the mathematics lesson or while solving a mathematical problem (Çanakçı & Özdemir, 2011). A mathematical problem-solving attitude can be defined as students' negative or positive orientations regarding the mathematical problem-solving process (Çanakçı, 2008). Caring about original solutions in problem-solving processes and including problems that can be solved in different ways can effectively improve students' attitudes towards mathematics and mathematical problem-solving (Tat, 2021, p.117).

One of the critical affective factors affecting success in mathematics is the self-efficacy perceptions of students (Usher, 2009). Students' high self-efficacy perception is vital to success (Ünlü, 2021, p.55). In this particular situation, it is recommended that self-efficacy perceptions be developed to achieve the desired goals in the updated secondary school mathematics curriculum (MONE, 2018). In other words, students' ability to pose mathematical problems can be shaped by their self-efficacy perceptions (Özgen & Bayram, 2019) because the perception of mathematics self-efficacy is the current belief that enables the student to fulfill the responsibilities related to mathematics with his existing potential and to form the given problem correctly (Hackett & Betz, 1989). Self-efficacy belief in problem-posing is the self-judgment of people to pose problems by making use of their existing mathematical knowledge with the help of various methods by inferring from the mathematical problems they encounter, different mathematical models or events they see in daily life (Özgen & Bayram, 2019).

When the studies in the literature were examined, it was seen that there were no studies examining the relationship between the problem-solving attitudes of secondary school students and their self-efficacy toward problem-posing, and it was thought that such a study was needed. When the literature is examined, It is seen that there are studies on attitudes towards problem-solving (Altuntaş & Erişen, 2021; Bozan, 2008; Durmaz, 2014; İlhan et al., 2021; Kanbolat & Balta, 2019; Özgen et al., 2017a; Özgen, et al., 2017b; Şanlıdağ & Aykaç, 2021; Tum & Kutluca, 2021), studies on problem posing self-efficacy (Altuntaş & Tanrısever, 2017; Çelik &

Arslan, 2022; Geçici & Aydın, 2019; Güç & Keskin, 2021; Mersin & Akkaş, 2023; Özgen & Bayram, 2020; Özgen et al., 2018; Ünlü & Aktaş, 2016).

Importance of Research

Studies examining the relationship between problem-posing and problem-solving can be found by reviewing the literature. However, it has been observed that the number of studies examining the relationships between these skills from the affective aspect is limited. Studies examining the relationship between problem-solving and problem posing (Aktaş, 2021; Atlıhan, 2021; Ayketin-Uskun et al., 2020; Aykurtlu, 2019; Bağdat, 2020; Bakırcı, 2014; Baki & Çelik, 2018; Demirci, 2018; Divrik, 2019; Dölek, 2018; Duran et al., 2015; Erdoğan, 2019; Geçici & Aydın, 2019; Gündoğdu, 2020; Kartal & Öcal, 2024; Kavuncu & Yenilmez, 2021; Kılıç, 2013; Mayan, 2019; Salman, 2012; Turhan, 2011; Turhan & Güven, 2014; Türer, 2022; Yıldız Üstündağ, 2021; Yıldız & Baltacı, 2016) are seen in the literature.

Problem solving skills are one of the 21st century skills. For this reason, it is important for students to gain problem solving skills in mathematics classes. The relationship between their attitudes towards problem solving, which they can apply throughout their lives, and their self-efficacy towards posing problems may be a research finding that will allow students to increase their problem solving attitudes by gaining problem posing skills in the future. For this reason, this study is considered important in terms of determining whether the problem solving self-efficacy has an effect on students' problem solving attitudes. Furthermore, cognitive research on problem-solving and problem-posing seems to predominate. In this study, it is mainly concerned with examining the affective relations of these two skills. In this respect, it is considered to be an original work.

Purpose of Research and Problem of Research

Studies Today, it is not enough for people to learn only mathematics, and the desire to be more competent in every field requires problem-solving and problem-posing skills, which are essential subjects of mathematics education. For this reason, this study aimed to explore the relationship between the total scores of secondary school students from the MPSAS and the total scores they got from PPSES. Within the framework of the stated objective, answers to the following research problems were sought:

1. What is the level of mathematics problem-solving attitudes of secondary school students?
2. What is the level of problem-posing self-efficacy of secondary school students?
3. Do secondary school students' mathematical problem-solving attitudes differ significantly in terms of their demographic characteristics of the students?
4. Does the problem-posing self-efficacy of secondary school students differ significantly in terms of their demographic characteristics?
5. Is there a statistically significant relationship between secondary school students' mathematical problem-solving attitudes and their problem-posing self-efficacy?

Method

Research Model

The method used in this study is correlational research, a type of quantitative research method. The correlational research model was adopted since the research subject examines the relationship between secondary school students' mathematical problem-solving attitudes and their self-efficacy toward problem-posing. The correlational research model covers the relationship between parameters within a group and primarily studies that give information about the possibility of cause and effect among the parameters (Karasar, 2012). The study applied the mathematics problem-solving attitude and problem-posing self-efficacy scales to students at secondary schools. After the data are collected, the relationship between these two features will be examined.

Study Population

The study sample consisted of 223 students selected from 5th, 6th, 7th, and 8th-grade students, 66 of whom are private and 163 of whom are studying in state secondary schools in the 2022-2023 academic years. This study used a non-random, convenient sampling method to determine the students. The most crucial goal of the appropriate sampling method is to keep the loss of money and workforce to a minimum (Büyüköztürk et al., 2010). The study sample consisted of secondary school students studying at the schools where the researchers worked, who could easily reach them and wanted to participate voluntarily with their parent's permission.

Data Collection Tools

Mathematical problem-solving attitude and problem-posing self-efficacy scales were applied to gather data, and the necessary explanations about these tools are given below.

Demographic Information Form

In the demographic information form, there are questions on the students' gender, grade levels, and school types aimed to identify the students' interests.

Mathematical Problem-Solving Attitude Scale (MPSAS)

The MPSAS developed by Çanakçı (2008), having a Cronbach's alpha internal consistency coefficient of .84, is a valid and reliable scale. It consists of 19 items. The MPSAS developed by Çanakçı (2008), having a Cronbach's alpha internal consistency coefficient of .84, is a valid and reliable scale. It consists of 19 items. As a result of the factor and item analyses, the remaining 19 items were grouped into two dimensions: "Enjoyment" and "Teaching" dimensions. The total variance explained by both factors was determined as 42.693%. The Pearson correlation coefficient calculated using the test-retest technique was 0.89 (Çanakçı, 2008). This scale measures secondary school students' mathematical problem-solving attitudes' cognitive, affective, and behavioral dimensions. When the sub-dimensions of the two-dimensional scale are examined, ten items in the first dimension measure the students' perceptions of problem and problem-solving (dimension of enjoyment), and nine items in the second dimension measure the students' perceptions of themselves, the teacher, and the process (dimension of teaching) while solving problems. In addition, ten items in the scale were coded negatively (M1, M7, M10, M11, M12, M13, M14, M15, M16, M18) and the remaining nine items were coded as positive. This 5-point Likert-type scale is scored as follows: I completely agree= 5, agree= 4, undecided= 3, disagree= 2, strongly disagree= 1. Positive items were scored as 5-4-3-2-1, and negative items were reversed and scored as 1-2-3-4-5. The total points received will be divided by the number of items, and the student's score will be determined out of 5. Scores from the scale;

4.21 and above: Absolutely I agree (math problem unravel oriented attitudes A lot positive)

3.41 - 4.20: Agree (math problem unravel oriented attitudes positive)

2.61- 3.40: Undecided

1.81- 2.60: Disagree (math problem unravel oriented attitudes negative)

1.80 and below: Absolutely disagree (math problem unravel oriented attitudes A lot negative) (Çanakçı, 2008). In this study, the Cronbach alpha value for the total scale was .890.

Self-Efficacy Scale for Posing Problems

This scale, developed by Özgen and Bayram (2019), with a Cronbach's alpha internal consistency coefficient of .85, is valid and reliable and consists of 24 items. The data used for factor analysis show that the scale consists of 5 factors. The percentage of variance explained by all factors was calculated as 45.64%. The fit indices obtained from confirmatory factor analysis showed a fit between the model and the data, and that the proposed model showed a good or acceptable fit. As a result of the analysis, a 24-item problem-posing self-efficacy scale with a 5-point Likert-type scale was developed. It is seen that the factor loadings obtained in the exploratory factor analysis are between .435 and .710. These findings show that the factor loadings obtained are above the specified lower limits (Özgen & Bayram, 2019). This scale aims to measure the problem-posing self-efficacy of secondary school students. The scale has five dimensions, and when its sub-dimensions are examined, six items in the first dimension indicate the relationship of students with problem-solving (RWPS), six items in the second dimension indicate the students' difficulties in the problem-posing process (DEPPP), six items in the third dimension shows the benefits of students' problem-posing (BOPP), the fourth dimension in the fifth dimension, three items were named as students' problem-posing in the learning process (PPILP), and three items in the fifth dimension were named as students' problem-posing situations (PPS). While preparing the scale, all stages of problem-posing were discussed. There are 24 items on the scale, seven of which are negative, including M1, M8, M12, M15, M17, M23, and M24), and the remaining 17 are positive. In addition, this scale is misused based on a 5-point Likert-type scale, including strongly agree, agree, undecided, disagree, and strongly disagree. Positive items were scored as 5-4-3- 2-1, and negative items were reversed and scored as 1-2-3-4-5. With these scores, the lowest score from the scale is considered as 24, and the highest score is 120. High scores show strong self-efficacy beliefs for problem-posing, and low scores indicate weak self-efficacy beliefs for problem-posing (Özgen & Bayram, 2019). The Self-Efficacy Scale for Posing Problems was developed by Özgen and Bayram (2019), with a Cronbach's alpha internal consistency coefficient of .85. The Cronbach's alpha internal consistency coefficient of the scale in this study is .921. In this study, Cronbach alpha values in both scales are higher than Cronbach alpha values in scale development. Cronbach alpha values above .800 indicate that the reliability level of the scale is very high (Özdamar, 2017).

Data Analysis

The Google form containing the mathematical problem-solving attitude scale and the self-efficacy scale for problem-posing were sent to the study group after getting the required permissions.

All the data collected for the study were first pulled from Google Forms and transferred to the computer as an Excel file. The collected data was analyzed using a statistical package

program. With the statistical package program, first looking at the normality distributions of the data, kurtosis, skewness, and Kolmogorov-Smirnov test values were examined. These results are given in Table 1.

Table 1. Skewness and Kurtosis Analyses

	Kolmogorov- Smirnov	Kurtosis	Skewness	Reliability
Enjoyment		-.524	-.204	,840
Teaching		1,247	-.788	,435
MPSAS	,200 *	-.005	-.408	,890
RWPS		1,522	-.842	,783
DEPPP		-,103	-,158	,749
BOPP		,324	-,651	,809
PPILP		,271	-.492	,637
PPS		,335	-.446	,699
PPSES	,052	,976	-.497	,921

(MPSAS: Mathematics Problem-Solving Attitude Scale- RWPS: Relationship with Problem-Solving-DEPPP: Difficulties Encountered in the Problem-Posing Process- BOPP: Benefits of Problem-Posing – PPILP: Problem Posing in Learning Process- PPS: Problem Posing Situations- PPSES: Problem Posing Self-Efficacy Scale)

When the results of the test are examined in Table 1, it has been determined that the scores obtained from the scales have a normal distribution since the kurtosis and skewness values of the mathematics problem-solving attitude scale and its sub-dimensions and the data for the problem-posing self-efficacy scale and sub-dimensions are between ± 2 (George & Mallery, 2010). Also, the Kolmogorov-Smirnov test indicated that the total scores of the two scales have a normal distribution.

It was thought that parametric tests should be used for analysis with the finding that the data had a normal distribution. The t-test was used to know whether there was any difference between the mathematics problem-solving attitude scale, its sub-dimensions, and the problem-posing self-efficacy scale and sub-dimensions in terms of the variables of gender and school type. One Way ANOVA test was used to reveal whether there is any difference between the mathematics problem-solving attitude scale and its sub-dimensions and the problem-posing self-efficacy scale and sub-dimensions in terms of the variable of the grade level. Correlation analysis was performed to identify if there was a statistically significant difference between the total scores obtained from the mathematics problem-solving attitude scale and the total scores obtained from the self-efficacy scale for problem-posing. Pearson correlation test was used to see if there is any relationship between the mathematics problem-solving attitude scale and problem-posing self-efficacy scale.

Findings

Findings on the level of mathematical problem solving attitudes of secondary school students

The research's first problem is the mathematical problem-solving attitudes level of students at secondary schools. The results found are given in Table 2.

Table 2. Arithmetic Average and Standard Deviation Values for MPSAS

	N	$\bar{X}$	SD
Enjoyment	223	31.23	10.13
Teaching	223	32.90	3,57
MPSAS	223	64.13	12.32

According to data in Table 2, students' mathematical problem-solving attitudes were at a high level (= 64.13; SD = 12.32) with the total scores of MPSAS. Among its sub-dimensions, the teaching dimension (= 32.90; SD= 3.57) is higher than the enjoyment dimension ($X=31.23$; SD= 10.13).

Findings on the level of problem posing self-efficacy of secondary school students

The research's second problem is the level of problem-posing self-efficacy of secondary school students. The results found are given in Table 3.

Table 3. Average and Standard Deviation Values for PPSES

	N	$\bar{X}$	SD
RWPS	223	24.11	3.71
DEPPP	223	20.66	4.58
BOPP	223	20.90	4.81
PPILP	223	10.77	2.49
PPS	223	10.37	2.48
PPSES	223	86.81	15.19

As seen in Table 3, it was determined that the total scores obtained from the problem-posing self- efficacy scale and the students' self-efficacy towards problem-posing, PPSES, were at a high level ($X=86.81$; SD= 15.19). Among its sub-dimensions, the RWPS dimension ($X=24.11$; SD= 3.71) is seen to be at a higher level than other sub-dimensions. DEPPP size ($X=20.66$; SD= 4.58) dimension ($X=20.90$; SD= 4.81) at medium level; PPILP PPS with dimension ($X=10.77$; SD= 2.49) dimension ($X=10.37$; SD= 2.48) is seen to be at a low level.

Findings on the level of significant difference in secondary school students' mathematical problem solving attitudes according to demographic characteristics of students

a) The research's 3rd peoblem is the mathematical problem-solving attitudes of secondary school students differ significantly according to gender. Independent samples t-test was conducted for the students' scores from the mathematics problem-solving attitudes scale. The results found are shown in Table 4.

Table 4 . t Test Analysis of MPSAS Scores According to Gender

Variable	Groups	N	$\bar{X}$	SD	t	p
MPSAS	Girl	163	64.0	12.7	,137	,891
	Boy	60	64.3	11.3		
Enjoyment	Girl	163	31.1	10.2	,298	,766
	Boy	60	31.5	9.9		
Teaching	Girl	163	32.9	3.7	-	,711
	Boy	60	32.7	2.9		

According to the data obtained from the t-test (Table 4), $p=.766$ for enjoyment, $t=.298$; $p=.711$, $t=-.371$ for teaching; $p=.891$, and $t=.137$ for MPSAS. It is concluded that the total scores and sub-dimensions of teaching with enjoyment and the total scores obtained from the MPSAS are $p > .05$ and that the total scores and sub-dimensions of the MPSAS do not make a meaningful difference in terms of the variable of the gender. In addition, it was determined that the mean scores of the sub-dimensions of enjoyment and teaching and the total scores of the MPSAS did not differ significantly considering the variable of the gender.

b) The research's 3rd problem is whether the mathematics problem solving attitudes of secondary school students show a significant difference according to school type. Independent samples t-test was conducted for the scores of the students from the math problem solving attitude scale. The results found are presented in Table 5.

Table 5. t Test Analysis of MPSAS Scores According to School Type

Variable	Groups	N	$\bar{X}$	SD	t	p	Cohen's d
MPSAS	Private	66	59.7	11.6	-3,510	,001	0.52
	Public	157	65.9	12.1			
Enjoyment	Private	66	27.6	9.4	-3,510	,001	0.52
	Public	157	32.7	10.0			
Teaching	Private	66	32.1	3,4	-2,117	,035	0.31
	Public	157	33.2	3,5			

When Table 5 is examined, $p=.001$, $t=-3.510$; for teaching $p=.035$, $t=-2.117$; and $p=.001$, $t=-3.510$ for MPSAS are found. Since the sub-dimensions of liking and teaching and the total scores of the MPSAS obtained are $p < .05$, it is concluded that the total scores and sub-dimensions of the MPSAS create a significant difference in terms of the school type . When Cohen's d coefficient is examined, a moderate effect size is seen in the MPSAS and enjoyment sub-dimensions (Cohen's $d=.52$). In the sub-dimension of teaching, it is seen to be at a weak level (Cohen's $d=.31$). In addition, it was determined that the average scores of the formal school students were significantly higher in terms of the school type of the sub-dimensions of enjoyment and teaching and the total scores of the MPSAS.

c) The research's 3rd problem is whether the mathematics problem solving attitudes of middle school students show a significant difference according to their grade level. One-way ANOVA (one-factor analysis of variance) test was conducted for the scores of the students from the mathematics problem solving attitude scale. The results found are given in Table 6.

Table 6. ANOVA Analysis of MPSAS Scores According to Grade Level

Variable	GRADE Düzeyi	N	$\bar{X}$	SD	F	p	Cohen's d
MPSAS	5th GRADE	69	68.5	11.9	5,832	,001	0.75
	6th GRADE	61	63.3	10.6			
	7th GRADE	46	63.2	13.1			
	8th GRADE	47	59.4	12.2			
Enjoyment	5th GRADE	69	34.9	10.2	5,410	,001	0.73
	6th GRADE	61	30.3	9.2			
	7 th GRADE	46	30.4	10.3			
	8th GRADE	47	27.7	9.5			
Teaching	5th GRADE	69	33.6	2.8	3,241	,023	0.53
	6th GRADE	61	33.0	3,5			
	7th GRADE	46	32.8	3.8			
	8th GRADE	47	31.6	3.9			

When Table 6 is examined, $p=.001 < .05$; $p=.023 < .05$ for teaching; $p=.001 < .05$ for MPSAS; found. Therefore, there is a statistically meaningful difference in enjoyment, teaching, and total scores of MPSAS according to the grade level variable of the total scores obtained in

MPSAS. When Cohen's d coefficient is considered, a moderate effect size is seen in MPSAS and all sub-dimensions (Cohen's $d > .5$). The Scheffe test was performed to find out which grades had significant differences. There is a statistically meaningful difference between 5th and 8th grades in favor of 5th grades regarding total scores, enjoyment, and teaching dimensions of MPSAS.

Findings on the level of significant difference in middle school students' problem posing self-efficacy according to demographic characteristics of students

a) The research's 4th problem is the problem posing self-efficacy of secondary school students differ significantly according to gender. Independent samples t -test was conducted for the students' scores from the problem posing self-efficacy scale. The results found are given in Table 7.

Table 7. t test Analysis of PPSES Scores According to Gender

Variable	Groups	N	$\bar{X}$	SD	t	p
PPSES	Girls	163	87.6	15.5	-1.31	.189
	Boys	60	84.6	13.9		
RWPS	Girls	163	24.2	3.72	-.83	.406
	Boys	60	23.7	3.67		
DEPPP	Girls	163	21.0	4.62	-1.91	.057
	Boys	60	19.7	4.37		
BOPP	Girls	163	21.1	4.87	-1.06	.287
	Boys	60	20.3	4.64		
PPILP	Girls	163	10.7	2.46	.12	.904
	Boys	60	10.8	2.59		
PPS	Girls	163	10.5	2.50	-1.34	.181
	Boys	60	10.0	2.42		

When Table 7 is examined, the results of the t -test indicated that $t = -1.31$ and $p = .189$, for PPSES, the total score of self-efficacy for problem posing; $t = -.83$ and $p = .406$ for RWPS; $t = -1.91$ and $p = .057$ for DEPPP; $t = -1.06$ and $p = .287$ for BOPP; $t = .12$ and $p = .904$, for PPILP; $t = -1.34$ and $p = .181$ for PPS. It is concluded that the problem-posing self-efficacy scale and all its sub-dimensions do not make any statistically significant difference in terms of the variable of the gender since the total scores obtained from the RWPS, DEPPP, BOPP, PPILP and PPS sub-dimensions and PPSES; the problem-posing self-efficacy scale, are $p > .05$. In addition, it was determined that the average scores of all sub-dimensions and the self-efficacy scale for problem-posing did not differ significantly in terms of the variable of the gender.

b) The research's 4th problem is whether the problem posing self-efficacy of secondary school students show a significant difference according to school type. Independent samples t -test was conducted for the scores of the students from the problem posing self-efficacy scale. The results found are given in Table 8.

Table 8. t Test Analysis of PPSES Scores According to School Type

Variable	Groups	N	$\bar{X}$	SD	t	p	Cohen's d
PPSES	Private	66	83.6	17.1	-2.02	.044	0.28
	Public	157	88.1	14.1			
RWPS	Private	66	23.2	4.4	-2.23	.026	0.30

	Public	157	24.4	3.3		
DEPPP	Private	66	20.3	5.0	-,761 ,447	-
	Public	157	20.8	4.3		
BOPP	Private	66	19.8	5.3	-2.19 ,029	0.30
	Public	157	21.3	4.5		
PPILP	Private	66	10.2	2.7	-1.99 ,048	0.27
	Public	157	10.9	2.3		
PPS	Private	66	10.0	2.6	-1.37 ,170	-
	Public	157	10.5	2,4		

When Table 8 is examined, as a result of the t-test, $p=.026$ for RWPS, $t=-2.23$; $p=.447$ for DEPPP, $t=-.761$; for BOPP $p=.029$, $t=-2.19$; $p=.048$, $t=-1.99$ for PPILP; $p=.170$, $t=-1.37$ for PPS; $p=.044$, $t=-2.02$ for the total score of self-efficacy for problem posing. Since the DEPPP and PPS sub-dimensions were $p > .05$, there was not any statistically significant difference in the self-efficacy scale for problem-posing according to the school type variable, and the total scores of the RWPS, BOPP, PPILP sub-dimensions and the self-efficacy scale for problem-posing were $p < .05$. It is concluded that there is a meaningful difference in terms of the variable of the school type in the self-efficacy scale. When Cohen's d coefficient is examined, a low level of effect size is observed in the total self-efficacy scores for problem-posing and in the sub-dimensions of RWPS, BOPP, and PPILP (Cohen's $d < .5$). In addition, it was determined that the average scores of all sub-dimensions and the total scores obtained from the self-efficacy scale for problem-posing did not differ considerable in terms of the variable of the school type.

c) The research's 4rd problem is whether the problem posing self-efficacy of middle school students show a significant difference according to their grade level. One-way ANOVA (one-factor analysis of variance) test was conducted for the scores of the students from the problem posing self-efficacy scale. The results found are given in Table 9.

Table 9. t Test Analysis of PPSES Scores According to Grade Level

Variable	Grade level	N	$\bar{X}$	SD	F	P	Cohen's d
PPSES	5 TH GRADE	69	91.5	14.9	5,060	,002	0.70
	6 TH GRADE	61	86.9	11.9			
	7 TH GRADE	46	85.6	16.9			
	8 TH GRADE	47	80.7	15.6			
RWPS	5 TH GRADE	69	25.1	3,4	4,681	,003	0.10
	6 TH GRADE	61	24.4	3.1			
	7 TH GRADE	46	23.6	4.1			
	8 TH GRADE	47	22.6	3.9			
DEPPP	5 TH GRADE	69	21.2	5.0	1,496	,217	-
	6 TH GRADE	61	20.4	4.3			
	7 TH GRADE	46	21.1	4.3			
	8 TH GRADE	47	19.6	4.3			
BOPP	5 TH GRADE	69	22.7	4.2	6,268	,000	0.82
	6 TH GRADE	61	20.7	4.1			
	7 TH GRADE	46	20.2	5.6			
	8 TH GRADE	47	19.0	4.8			
PPILP	5 TH GRADE	69	11.2	2.6	2,283	,080	-
	6 TH GRADE	61	11.0	2.2			
	7 TH GRADE	46	10.4	2.6			
	8 TH GRADE	47	10.1	2.3			

PPS	5 TH GRADE	69	11.2	2.3	6,100	,001	0.74
	6 TH GRADE	61	10.3	1.9			
	7 TH GRADE	46	10.1	2,5			
	8 TH GRADE	47	9.3	2.8			

When Table 9 is examined, $p=.003 < .05$ for RWPS; $p=.217 > .05$ for DEPPP; for BOPPP= $.000 < .05$; $p=.080 > .05$ for PPILP; $p=.001 < .05$ for PPS; $p=.002 < .05$ for the total score of self-efficacy for problem-posing. Therefore, according to the variable of grade level of the total scores obtained from the self-efficacy scale for problem posing, there is a significant difference in the total score of RWPS, BOPP, PPS, and self-efficacy for problem posing. There is no significant difference in the DEPPP and PPILP dimensions according to the grade level variable of the total score obtained from the self-efficacy scale for problem-posing. When Cohen's d coefficient is considered, it is identified that the total self-efficacy scores for problem-posing and moderate effect size in the PPS sub-dimension are observed (Cohen's $d > 5$). Considering Cohen's d coefficient, a low effect size level is seen in the PPILP sub-dimension (Cohen's $d < 5$). Considering Cohen's d coefficient, a high effect size level is seen in the BOPP sub-dimension (Cohen's $d = .82$). The Scheffe test was performed to identify which grades had meaningful differences. It was seen that there is a statistically significant difference between the 5th and 8th grades in favor of the 5th grades for the total scores obtained from the problem-posing self-efficacy scale.

Findings on the level of significant relationship between middle school students' attitudes towards mathematical problem solving and their self-efficacy towards problem posing

The research's 5rd problem is whether there is a significant relationship between middle school students' attitudes towards mathematical problem solving and their self-efficacy towards problem posing. Pearson correlation analysis was conducted to examine whether there is a relationship between the students' mathematical problem solving attitude scale and problem posing self-efficacy scale. The results found are given in Table 10.

Table 10. Correlation Analysis Results between MPSAS and PPSES

	MPSAS	
PPSES	$r = .681^{**}$	$p = .000$

****.** Correlation is significant at the 0.01 level (2-tailed)

When Table 10 is examined, Sig. Since (2-tailed) $= .000$, there is a significant relationship between the attitude scale of mathematical problem-solving and the self-efficacy scale for problem-posing. This correlation is .681, and it is a high level of positive correlation.

Simple regression analysis was performed to examine whether a mathematical problem-solving attitude predicts problem-posing self-efficacy, and the results are given in Table 11.

Table 11. Mathematics Regression Analysis on Whether Problem-solving Attitude Predicted Problem-posing Self-Efficacy

Independent Variable	Dependent Variable	B	S.E	(β)	t	p	R	R ²	F	p
MPSAS	PPSES	,840	,061	,681	8,312	,000	,681 _a	,461	191,091	,000 ^b

a. Predictors: (Constant), MPSAS

b. Predictors: (Constant), MPSAS

As seen in Table 11, the mathematical problem-solving attitude scale (MPSAS) significantly predicted problem-posing self-efficacy (PPSES) ($p = .000 < .050$). It was determined to have a positive effect and explained 46% of the total variance in problem-posing self-efficacy ($R = .681$; $R^2 = .461$).

Discussion and Conclusion

Many skills are to be gained in mathematics courses to shape and support their feelings, thoughts, and competencies for the situations they encounter in real life. Every student is expected to have problem-solving skills that are helpful in real life and are tried to be gained. These skills are affected by the affective and cognitive characteristics of the students.

Since problem-solving and problem-posing skills support each other, it can be said that these two skills cannot be considered dependent on each other. (Özgen et al., 2017b). These skills are affected by the affective and cognitive characteristics of the students. Also, the research math problem-solving attitude scale studied the relationship between self-efficacy and problem-posing scale. This study found a high correlation ($r = .681$) between problem-solving attitude and self-efficacy. Therefore, it can be said that effective characteristics may have an essential effect on mathematical problem-solving and problem-posing. The study determined that the average of the student's total scores from the mathematics problem-solving attitude scale was high. In their study, Özgen et al. (2017a) concluded that secondary school students' scores on the mathematics problem-solving attitude scale were high. They stated that the finding of this result may be due to the similarity of the problems faced by the students in their lives and their mathematical problems or their belief that problem-solving would benefit them. Taşpınar (2011) reached a similar conclusion in his study and determined that the 8th-grade students' perceptions of problem-solving in mathematics lessons were positive. Based on all these results, it can be said that students' belief that problem-solving is beneficial significantly affects their high attitude towards problem-solving. In the sub-dimensions of the scale, it was determined that the average of the teaching sub-dimension was higher than the average of the sub-dimension of enjoyment. Based on this result, it is seen that the teaching approaches and strategies used in the lessons are more effective in the problem-solving attitudes of the students. Küpçü (2012) found in his study that the teaching with activity model increased students' problem-solving success. In their study on inquiry-based teaching practices, Serin and Korkmaz (2018) also concluded that students' success in solving mathematical problems increased. Since the problem-solving attitude was found to be high in this study, it can be said that the teachers of these students use teaching methods and techniques that will increase the problem-solving attitude in mathematics classes. The study determined that the average scores obtained by the students on the self-efficacy scale for problem-posing were high. A study by Arslan and Çelik (2022) concluded that secondary school students' problem-posing self-efficacy is generally high. They argued that students with high problem-posing self-efficacy can be more successful in posing and solving problems. Similarly, Geçici and Aydın (2019) found a moderately significant link between posing geometry problems and their self-efficacy towards geometry in their study with 8th-grade students. Among its sub-dimensions, it is seen that the sub-dimension of RWPS is at a higher level than the other sub-dimensions. The DEPPP sub-dimension and the BOPP sub-dimension are moderate. It was determined that the BOPP sub-dimension and the PPS sub-dimension were at a low level. In this study, although there was no difference in PPS and all sub-dimensions (PPSES, RWPS, DEPPP, BOPP, PPILP) between both girls and boys, it was observed that PPS and all sub-dimensions were high. According to the data collected after 4 years compared to 2019, it can be said that the mathematics curriculum implemented after 2019 positively affected the students' problem-solving self-efficacy. However, confirming

this finding with different middle school students in different environments will contribute to the field.

The total scores of the attitude scale toward solving mathematical problems did not differ in terms of the variable of gender. In addition, it was identified that the mean scores of the sub-dimensions of enjoyment and teaching and the total scores of the MPSAS did not differ significantly according to the gender variable. In his study, Çanakçı (2008) concluded that the gender variable did not affect the mathematics problem-solving attitudes of secondary school students. Similarly, Özgen et al. (2017a) in their studies that identified that the gender variable did not affect students' mathematics attitudes. The fact that the variables affecting mathematics attitude are equally important for everyone has led to this result. In addition, students' high mathematical problem-solving attitudes can be seen as the fact that the mathematics course has a significant weight in most central exams and that the mathematics course is a main course in the curriculum of all levels. When we examine the results of all studies, it can be said that students' mathematical problem-solving attitudes are primarily positive and not affected by the gender variable.

It was found that the school-type variable affected the total scores and sub-dimensions obtained from the mathematics problem-solving attitude scale. Mathematical problem-solving attitudes of students differ according to school type. Moreover, it has been found that the average scores of the formal school students are higher than the school type variable of the sub-dimensions of enjoyment and teaching and the total scores of the MPSAS. That is, the scores of public school students on the problem-solving attitude scale are higher than those of private school students. Uğurluoğlu (2008), on the other hand, reached a contrary conclusion to the situation reached in his study and stated that the attitudes of private school students towards problem-solving are higher than those of students studying in public schools. The researchers considered that the reason for this different result may be that the students in private schools have richer learning environments or that 14 years have passed between the years in which the studies were conducted. However, this is the inference of the researchers; therefore, it should be studied in future research.

Students' mathematical problem-solving attitudes differ according to the grade level variable. When the secondary school students' attitudes to mathematics problem-solving were examined in terms of the variable of grade level, a significant difference was found between the 5th and 8th grades. The total scores of the 5th-grade students from the mathematics problem-solving attitude scale are higher than those in other grades. Furthermore, it was revealed that the mean scores of the 5th-grade students were higher for the total scores obtained from the MPSC and for all sub-dimensions of enjoyment and teaching, according to the grade level variable. In their studies, Çanakçı (2008), Öner (2019), and Koç (2014) determined that students' perceptions of mathematical problem-solving differ in terms of the variable of the grade level. As seen in the studies, it was concluded that the higher the grade level, the lower the attitude toward solving mathematical problems. Moreover, the study's results are supported because there is a high correlation between problem-solving attitude and problem-posing self-efficacy.

It was observed that the total scores obtained from the secondary school students' problem-posing self-efficacy scale did not differ in terms of gender. Geçici and Aydın (2019) revealed that the 8th-grade students' scores in the geometry problem-posing test did not differ in gender. Similarly, Sevgi and Çalışkan (2020) found that gender did not affect secondary school students' problem-posing self-efficacy. Additionally, it was identified that the mean

scores of all sub-dimensions of RWPS BOPP, PPILP, DEPPP, and PPS and the total scores obtained from the self-efficacy scale for problem-posing PPSES did not differ significantly in gender.

It was revealed that the school type variable affected the secondary school students' total scores obtained from the problem-posing self-efficacy scale and the sub-dimensions of PCII, BOPP, and PPILP. Students' problem-posing self-efficacy differs in terms of the type of school. It has been determined that the total scores obtained from the PSII, BOPP, and PPILP sub-dimensions and the self-efficacy scale for problem-posing are higher than the average scores of the official school students compared to the variable of school type. That is, the scores of public school students on the problem-posing self-efficacy scale PPSES are higher than those of private school students. However, it was found that the school type variable did not affect the DEPPP and PPS sub-dimensions.

It has been determined that the student's self-efficacy towards problem-posing also differs according to the grade level. According to the grade level variable, there is a significant difference between the total scores obtained from the self-efficacy scale for problem-posing and the sub-dimensions of RWPS, BOPP, and PPS. There is no significant difference in the sub-dimensions of DEPPP and PPILP according to the grade level variable. Considering the grade level variable in the self-efficacy scale for problem posing, it was seen that there was a significant difference between the 5th and 8th grades. The total scores of the 5th-grade students from the problem-posing self-efficacy scale are higher than those in other grades. Özgen and Bayram (2020) stated in their studies that the students' total scores from the self-efficacy scale decrease as the grade level increases. As the grade level increases, the decrease in self-efficacy towards problem-posing may be due to the abstraction of mathematics subjects and the anxiety levels of the students preparing for the central selection exams.

It has been identified that a highly significant relationship exists between secondary school students' mathematical problem-solving attitudes and their self-efficacy toward problem-posing. It has been observed that mathematical problem-solving attitudes and problem-posing self-efficacy affect each other. Özgen et al. (2017b) found a significant relationship between students' problem-solving attitudes and problem-posing skills in their study with 8th-grade students.

It was discovered that the total scores of secondary school students from the mathematics problem-solving attitude scale significantly predicted their scores from the problem-posing self-efficacy scale and had a high positive effect. It was concluded that 46% of the secondary school students' total scores on the math problem-solving attitude scale explained their total scores on the problem-posing self-efficacy scale. Doruk, Öztürk, and Kaplan (2016), Durmaz (2014), Hackett and Betz (1989), Ünlü et al. (2010), and Yürekli (2008) found in their studies that there is a positive relationship between attitude toward mathematics and self-efficacy perception towards mathematics. In other words, it can be interpreted that the higher the problem-solving attitudes of the students, the higher their self-efficacy toward problem-posing. Other studies are not up to date. The most recent study was conducted eight years ago, and unlike them, this study directly revealed the relationship between middle school students' problem-solving attitudes and problem-posing self-efficacy. Therefore, the findings of previous studies were confirmed in terms of different affective characteristics with this study. The fact that two essential affective characteristics, such as attitude and self-efficacy, were studied in terms of problem-solving and problem-posing will contribute to the study of affective characteristics in mathematics education.

It has been concluded that the problem-solving attitudes of secondary school students affect their self-efficacy towards posing problems. It is likely appropriate for teachers to create learning environments where problem-solving and problem-posing skills are used together in their lessons.

A significant difference is seen when the results are examined according to the school type variable. This significant difference is in favor of public schools. It is recommended that private school students, teachers, and parents cooperate more regarding student success and that their preparations for central exams do not take precedence over their lessons.

When the results are examined according to the class level variable, a significant difference is seen between the 5th and 8th grades. This significant difference is in favor of the 5th-grade students. In other words, it is seen that as the students' class level increases, both their problem-solving attitudes and their self-efficacy towards posing problems decrease. Considering that students prepare for central exams as their class level increases, it would be appropriate to include questions in the central exams where these two skills are presented in a way that supports each other.

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Etik kurul onayı

Etik Beyannamesi

Bu çalışmada “Yükseköğretim Kurumları Bilimsel Araştırma ve Yayın Etiği Yönergesi” kapsamında belirtilen kurallara uyulduğunu ve “Bilimsel Araştırma ve Yayın Etiğine Aykırı Eylemler” başlığı altında belirtilen eylemlerden hiçbirini gerçekleştirmediğimizi beyan ederiz. Aynı zamanda yazarlar arasında çıkar çatışmasının olmadığını, tüm yazarların çalışmaya katkı sağladığını ve her türlü etik ihlalde sorumluluğun makale yazarlarına ait olduğunu bildiririz.

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