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The Effect of Problem Posing Attitude on Problem Solving Attitude: The Mediating Role of Mathematical Self-Efficacy

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Abstract

In this study, the relationships between middle school students' problem posing attitudes, self-efficacy perceptions and problem-solving attitudes in mathematics were examined. The research was conducted according to the relational screening model and a structural equation model was tested to determine the causal relationships between the variables. A structural equation modelling was used to examine the mediating roles of mathematical self-efficacy perceptions in the effects of the problem posing attitudes on mathematical problem-solving attitudes. This study was carried out on 493 (251 girls, 242 boys) students studying in a secondary school affiliated to the Ministry of National Education in **** province in Türkiye in the fall term of the 2023-2024 academic year. Data were collected via online questionnaire form. The findings indicated that a) students' problem posing attitudes had a direct and positive effect on students' mathematical problem-solving attitudes; b) students' problem posing attitudes had a direct and positive effect on students' mathematical self-efficacy perceptions c) students' mathematical self-efficacy perceptions had a direct and positive effect on students' mathematical problem-solving attitudes; In addition, mathematical self-efficacy perceptions play a partial mediating role in the relationship between students' problem-posing attitudes and mathematical problem-solving attitudes.

Keywords: Mediating effect, mathematical self-efficacy, problem posing, problem solving

Problem Kurma Tutumunun Problem Çözme Tutumuna Etkisi: Matematiksel Öz Yeterliliğin Aracı Rolü

Özet

Bu çalışmada ortaokul öğrencilerinin matematikte problem kurma tutumları, öz-yeterlik algıları ve problem çözme tutumları arasındaki ilişkiler incelenmiştir. Araştırma ilişkisel tarama modeline göre yürütülmüş olup değişkenler arasındaki nedensel ilişkileri belirlemek amacıyla bir yapısal eşitlik modeli test edilmiştir. Problem kurma tutumlarının matematiksel problem çözme tutumları üzerindeki etkisinde matematiksel öz-yeterlik algılarının aracılık rolünü incelemek amacıyla yapısal eşitlik modellemesi kullanılmıştır. Bu çalışma, 2023-2024 eğitim-öğretim yılı güz döneminde Türkiye'nin **** ilindeki Milli Eğitim Bakanlığı'na bağlı bir ortaokulda öğrenim gören 493 (251 kız, 242 erkek) öğrenci üzerinde gerçekleştirilmiştir. Veriler çevrimiçi anket formu aracılığıyla toplanmıştır. Bulgular, a) öğrencilerin problem kurma tutumlarının, öğrencilerin matematiksel problem çözme tutumları üzerinde doğrudan ve olumlu bir etkiye sahip olduğunu; b) öğrencilerin problem kurma tutumlarının, öğrencilerin matematiksel öz-yeterlik algıları üzerinde doğrudan ve olumlu bir etkiye sahip olduğu c) matematiksel öz-yeterlik algılarının, öğrencilerin matematiksel problem çözme tutumları üzerinde doğrudan ve olumlu bir etkiye sahip olduğu; ayrıca öğrencilerin problem kurma tutumları ile matematiksel problem çözme tutumları arasındaki ilişkide matematiksel öz-yeterliğin kısmi aracılık rolü oynadığı belirlenmiştir.

Anahtar Kelimeler: Aracılık etkisi, matematik öz-yeterliği, problem kurma, problem çözme

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Introduction

Students' habits and attitudes about problem-solving and problem posing are one of the main subjects of studies in the field of mathematics education. A problem is a situation that learners encounter, requires a solution, and the solution is not known directly (Posamentier & Krulik, 2016). A math problem is a task presented to students in an instructional setting that poses a question that needs to be answered, but students do not have a ready-made procedure or strategy to answer (Lester & Cai, 2016). The specific activities of mathematics include problem posing, problem-solving, using symbols, generalizing and proving processes; however, if the learning and teaching environments can be designed to reflect these processes during the teaching of school mathematics, the meaning of mathematics being taught in schools becomes clear (Baki, 2018: 91). Studies have shown that education programs have a positive effect on students' unique problem posing and problem-solving abilities, and their problem posing and problem-solving beliefs and attitudes (Chen et al., 2010; English, 1998). It has been reported that teaching through problem-solving improves the problem-solving performance of students (Lester & Cai, 2016), while problem posing-based mathematics teaching has positive effects on students' problem-solving success (Işık et al., 2012).

Students may be asked to model mathematically to solve a problem they will encounter in daily life, to express the problem in mathematical terms, or to pose a problem by identifying the missing items for a solution in a given problem (Ministry of National Education [MoNE], 2015). Problem-solving, which is an integral part of mathematics, is not only a goal of learning mathematics, but an important way of doing mathematics (National Council of Teachers of Mathematics [NCTM], 2000). Problem-solving is a basic skill that is reinforced in all learning areas, and it is a meaningful learning process that expands and deepens mathematical knowledge as well as reinforcing a mathematical knowledge (MoNE, 2015). Problem-solving means participating in a task for which the solution method is not known beforehand (NCTM, 2000). Problem-solving is not just a product, but a process or method of combining information in a new (non-routine) way to solve a problem (Gonzales, 1998). Therefore, considering problem posing separately from problem-solving means ignoring most problem posing features (Özdemir & Sahal, 2018).

Problem Posing Attitude

Problem posing is a fundamental component of mathematics teaching and learning (Leavy & O'Shea, 2011; Stickles, 2011) and is considered an intellectual activity of critical importance for researchers in mathematics education (Cai et al., 2015; Silver & Cai, 2005). Problem posing is a reformulation of a problem that arises in the process of generating a new problem or solving a problem (English, 1997). In this context, problem posing can be defined as an effective teaching strategy used to generate a new problem from a given situation or experience.

Today, many countries include problem posing in their mathematics curriculum (Mersin & Kılıç, 2021). NCTM emphasizes the importance of students' participation in problem posing activities and recognizes problem posing as an alternative contemporary educational approach

(NCTM, 2000). Problem posing in Türkiye was included in the newly developed Mathematics curriculum based on the constructivist learning approach in 2006 (Kılıç, 2017) and activities for problem posing began to be included (MoNE, 2013; 2018). The inclusion of problem posing in the mathematics curriculum is a valuable component of mathematics teaching. Problem posing in meaningful contexts can provide insight into students' thinking and understanding, appeal to different levels of competence, emphasize mathematical structure and core concepts, help teachers become more mathematically proficient, and ultimately improve the problem-posing skills of both teachers and students (English, 2020).

Problem posing is a reflective and dynamic process that allows students to reflect on their mathematical perceptions (Kılıç, 2017). In this way, it can give important information about students' perceptions and attitudes towards problem-solving and mathematics (Brown &Walter, 2005). English (1997) argues that problem posing increases students' thinking, problem-solving skills, attitudes and self-confidence in mathematics, and enables them to understand mathematical concepts in a broader context. Through problem posing activities, students can improve their problem-solving, better understand mathematical concepts, processes and explore the relationship between them (Akay & Boz, 2010). In addition, the problem creator focuses not only on the underlying structures of the problem, but also on the extent to which the problem solver can interpret the components of the problem (Lowrie, 2002). Attitude towards problem posing is the emotional and mental readiness to pose problems or liking/disliking problem posing, belief in being good/bad in problem posing, and the tendency to participate in or avoid problem posing activities (Katrancı & Şengül, 2019). A meta-synthesis study showed that problem posing activities provide significant benefits on mathematics achievement, problem-solving skills, emerging problem levels, and attitudes towards mathematics (Rosli et al., 2014). Studies show that problem posing activities have a positive effect on mathematics attitude (Akay & Boz, 2010; Günhan et al., 2019; Turhan & Güven, 2014), problem-solving attitude (English, 1997; Kaba & Sengul, 2017) and mathematics self-efficacy perception (Akay & Boz, 2010).

Problem Solving Attitude

Problem-solving attitude can be defined as students' readiness for the problem-solving process or their positive/negative beliefs in this process and their tendency to be interested in, enjoy or avoid problem-solving (Tsai & Tang, 2017). In the problem-solving process of the students in the mathematics curriculum; the emphasis is on understanding the problem, planning the solution, implementing the plan, checking the correctness and validity of the solution, and finally generalizing the solution and observing the problem posing processes (MoNE, 2013). In other words, problem posing is the last step in the problem-solving process and is related to problem-solving competence.

Studies show that there is a close relationship between problem posing and problem-solving (Cai & Hwang, 2002; Leavy & O'Shea, 2011; Lowrie, 2002; Silver & Cai, 2005). However, it is possible to come across studies showing that there is no relationship between problem posing and problem-solving (Arikan & Unal, 2015). This situation can be explained by the existence of mediator variable or variables in the relationship between problem posing and problem-solving. Thus, we hypothesize that the attitudes towards mathematical problem posing can positively predict attitude towards problem-solving.

H1: *The direct relationship between the attitudes towards mathematical problem posing of students and their attitude towards problem-solving is positive and statistically significant*.

Mathematical Self-efficacy

Besides mathematical self-concept, self-efficacy and anxiety, motivation and metacognition are among the most emphasized and given importance among the non-cognitive structures related to mathematical problem-solving (Özcan & Gümüş, 2019). Self-efficacy has recently been investigated with various variables such as belief in mathematics self-efficacy, problem-posing, achievement and problem-solving (Akay & Boz, 2010; Recber et al., 2018; Temel, 2012; Xia et al., 2008). It has also been reported that mathematics self-efficacy has a positive direct effect on problem-solving skills (Taşkın et al., 2012). Perceived self-efficacy is a strong predictor of mathematical performance and problem posing is thought to be fundamental to mathematical learning (Nicolaou & Philippou, 2007). The perception of self-efficacy, one of the affective features of mathematics, is related to problem-solving (Kramarski et al., 2002) and problem posing (Özgen & Bayram, 2020). As can be seen, self-efficacy draws attention as both an explanatory variable and a predicted variable for problem-solving and problem-posing skills. Based on the above-mentioned findings, we then proposed these hypotheses:

H2: *The effect of attitudes towards mathematical problem posing of students on their perception of mathematics self-efficacy is positive and statistically significant*.

H3: *The effect of students' perception of mathematics self-efficacy on their attitudes towards mathematical problem solving is positive and statistically significant*.

Therefore, the mathematical self-efficacy could be a variable that can play a mediating role in the relationship between problem posing and problem-solving attitudes. From the review and theoretical underpinnings discussed above the following hypothesis was formulated:

H4: *After controlling the students' perception of mathematics self-efficacy, thus the relationship between the attitudes towards mathematical problem posing and attitude towards problem-solving is no more statistically significant*.

Although there are studies examining the relationships between problem posing attitude, problem-solving attitude and self-efficacy perception (for example, Pajares & Kranzler, 1995; Nicolaou & Philipou, 2007; Chen et al., 2010; Işık et al., 2012; Taşkın et al., 2013; Kaba & Sengul, 2019), no study examining the mediation relationship between these variables has been found so far. The main purpose of this study is to investigate the mediation role of self-efficacy perceptions in the relationship between middle school students' problem-posing attitudes and problem-solving attitudes. Self-efficacy, problem-posing and problem-solving attitudes, which are strong predictors of mathematics achievement, are seen as important basic concepts in terms of mathematics learning and teaching. Therefore, it is hoped that such a powerful approach to teaching mathematics through problem posing, problem-solving and self-efficacy variables will gain even more importance with this study. In this context, the fact that no study has been found in the literature on the direct and indirect relationships between attitudes towards problem posing and problem-solving and self-efficacy increases the importance of our current study. For this purpose, the current study focused on middle school students' attitudes towards mathematical problem posing, attitude towards problem-solving, and perception of mathematics self-efficacy. In the study, the model in Figure 1 was tested. In order to test this estimation model the mentioned above (H1-H4) hypotheses were examined.

Method

This study has a relational screening research design that examines the relationships between two or more variables. The purpose of a relational screening study is to determine the presence or level of change between two or more variables and to define the nature of the relationship (Heppner et al., 2013). In the correlational research strategy, two or more variables are measured, then the measurements are examined to identify any pattern of relationships that exist between the variables and to measure the strength of the relationship (Gravetter & Forzano, 2017). In the study, Structural Equation Model (SEM) was created to test relationship between the variables. The causal relationships between Mathematical Problem Posing Attitude (PPA), Perception of Mathematics Self-Efficacy (MSE) and Mathematical Problem-Solving Attitude (PSA) were investigated by simple mediation model. In the simple mediation model, there is a third variable called the mediator in the relationship between the independent variable and the dependent variable, which is affected by the independent variable and affects the dependent variable (Hayes, 2018).

Participants

The study group was determined by convenience sampling method. It was found appropriate to use this sampling method due to its advantages such as easy accessibility, economy and convenience. In this context, a secondary school in **** province in Türkiye was chosen for sampling study group. This school was chosen because of the school's central location, its location among districts with different socioeconomic levels, the high number of students, and the convenience of data collection opportunities. Data were gathered from 493 (251 girls, 242 boys) students in the 2023-2024 academic year. The ages of the students are between 14-15 old and the general academic achievement average is 72.6 ± 7.6 out of 100 points.

Instruments

The data of the study were obtained with three different scales as Mathematical Problem-Posing Attitude Scale, Mathematical Problem-Solving Attitude Scale, and Self-Efficacy Perception of Mathematics Scale. The definition and the reliability-validity analyses of these scales were given the following section includes.

Mathematical Problem-Posing Attitude Scale

In the research, a 5-point Likert-type scale consisting of 37 items, developed by Katrancı and Şengül (2019) was used to determine the mathematical problem posing attitude of the students. This scale has a four-factor which highly correlated structure. The scale was preferred since it was suitable for the academic level, language and culture of the participants. As a result of the factor analysis conducted by the researchers, a three-factor structure that explains 40.4 % of the total variance was obtained. The item factor loading values vary 0.46 to 0.75. The confirmatory factor analysis results have been reported to have good or acceptable fit indices (ChiSquare/df = 2.71, GFI = 0.88, NFI = 0.94, CFI = 0.96, RMSEA = 0.05, RMR = 0.09). The internal consistency coefficient of the whole scale was reported as 0.91 (Katrancı & Şengül, 2019). The internal consistency coefficient was calculated as 0.92 with the data collected within the scope of this study. Items from the scale included the following: “I feel good when I can pose a problem on a math topic”, “When posing a problem, I think I don't know math at all”.

Mathematical Problem-Solving Attitude Scale

The scale used to determine the attitudes of middle school students towards mathematical problem-solving was developed by Çanakçı and Özdemir (2011), and it is in 5-point Likert type and consists of 19 items. The reliability-validity study of the scale was carried out on a sample group (secondary school students, 6^{th}-8^{th}) similar to this study. The scale was preferred since it was also suitable for language and culture of the participants. Explanatory factor analysis results showed that the item factor loading values vary 0.46 to 0.75. Two factors are accounted for 43% of the explained total variance, the Cronbach-alpha reliability coefficient was reported as 0.84 (Çanakçı & Özdemir, 2011). In this study, the Cronbach-alpha reliability coefficient of the scale was calculated as 0.89. A high score indicates that attitudes towards mathematical problem-solving are at a high level. The scale items included the following: “I find problem solving boring”, “Problem solving is the most important part of learning mathematics”.

Self-Efficacy Perception of Mathematics Scale

Self-Efficacy Perception of Mathematics Scale which was developed by Umay (2001) was used in order to measure the perception of mathematics self-efficacy of participant students. The scale, consisting of 14 items, in 5-point Likert type, is three-dimensional. A high score from the scale indicates a high perception of mathematics self-efficacy. It has been reported that the Cronbach alpha internal consistency coefficient of the mathematics self-efficacy perception scale is 0.88 and the median of the validity coefficients of the scale items is 0.64 (Umay, 2001). The internal consistency coefficient was calculated as 0.80 with the data collected within the scope of this study. The scale items included the following: “I feel competent in solving problems in mathematics.”, “I notice that my self-confidence decreases while studying mathematics”.

Although the scales used have sub-dimensions, only the total score of scales were taken into account since there were very high correlations between the sub-dimensions and the relevant scale.

Procedure

Ethical permissions were obtained before starting data collection. The data were collected in the fall semester of the 2023-2024 academic year. The prepared data collection tools were delivered to the participants via online. For this purpose, the data collection tool was uploaded in the online platform, and the participants were able to access and answer the form thanks to the relevant link. (The used online platform application creates an access address and limits so that only one answer can be given for each multiple-choice question. Thanks to the access address, it is easier to access the questions, and with the answer limitation, all questions are answered and not left blank). In order to reach all students, the access address was sent to the 5th, 6th, 7th and 8th grade teachers by e-mail, respectively, in the light of the aforementioned information, and they were shared with the students and they were filled in. It was determined that the average time to answer the data collection tool was 14 minutes. The number of students who completed the data collection tool was 493. After the process was finished, the data obtained were exported in csv format and then analysed.

Data Analyses

For the analysis of the data, firstly, the mean score, standard deviation, skewness and kurtosis values obtained from the scales applied to the students were calculated and the normality of the distribution of the data was tested. Secondly, Pearson Correlation Coefficients were calculated to examine the relationships between the variables. Structural Equation Model (SEM) was used to test the hypothetical relationships between the constructs. One of the major advantages of SEM studies is that it allows the use of latent variables (Şimşek, 2007:16). SEM are used to test models that have causal relationships and correlation relationships between observed variables and latent variables (Dursun & Kocagöz, 2010). When the phenomenon of interest is complex and multidimensional, SEM is the only analysis that allows complete and simultaneous testing of all relationships (Tabachnick & Fidell, 2013). The following stages are generally followed in the structural equation model: 1) Establishing the structural model and determining the relationships between the variables in the model, testing the measurement model, 2) Obtaining the path diagram, determining the path coefficients of the relations (similar to the regression coefficients), 3) Examining the goodness of fit statistics of the model: Chi-square/Degree of Freedom, GFI, AGFI, CFI, RMSEA, RMR and Standardized SRMR are some of the frequently used fit statistics, 4) Interpretation of the findings by examining the structural model (Dursun & Kocagöz, 2010).

In the structural equation model, parcels were used as measurement variables. The parcel is the addition of the scale items that determine the latent variable to the model in groups, not one by one. Parceling is an optional pre-modeling step in SEM, it was used in this study due to the large number of items in the scales. To make the parcel, the items are summed or averaged, which are then used as indicators of measurement (Little et al., 2002). Parcels can be created using the subset-item-parcel approach or the all-item-parcel approach. In this study, with the all-item-parcel approach, each parcel was taken as the measurement variable as the average of 3 or 4 items. Using parceling does not result in loss of predictive precision in SEM, but rather results in more accurate score variance. (Matsunaga, 2008). In this study, as there is no comparison between samples and the indicators are constructed based on well-established concepts and principles from previous studies, there is no misidentification of the model and additional latent structures that are masked; therefore, it can be said that it is appropriate to use parceling.

In order to examine the mediating effect of MSE in the relationship between PPA and PSA, the model schematized in Figure 1 was tested. In Figure 1, PPA, MSE and Z are latent variables. PPA is determined by 12 parcels, MSE by 4 parcels and PSA by 6 parcels.

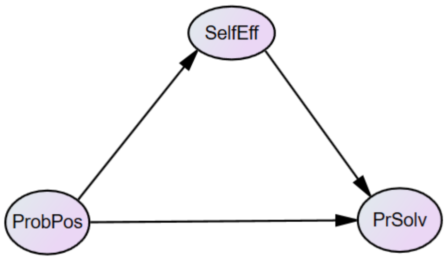

Figure 1. Tested model

Whether the structural equation model was confirmed by the data was evaluated with Chi-Square, ratio of Chi-square to degrees of freedom, GFI, CFI and RMSEA fit indices. The Sobel Test was used for the statistical significance of the mediation effect. The correlation coefficients between the descriptive statistics variables are presented. Statistical significance level was accepted as .05. Data analyses were performed with IBM SPSS 22.0 and AMOS 21 package programs.

Ethical Procedures

For this research, ethics committee permission was received from xxxx University Social and Human Sciences Scientific Research Ethics Committee with decision number 2023/xxx.

Findings

Write the entry here without changing the format and style. Some descriptive statistics such as arithmetic mean, standard deviation, skewness and kurtosis coefficients of the scores obtained from the scales applied to determine the PPA, PSA and MSE levels of the students included in the study were calculated. The obtained results are given in Table 1.

Tablo 1. Descriptive statistics regarding the scores obtained from the scales

Variables	PPA	MSE	PSA	$\bar{X}$± SE	Median	Skewness (SE)	Kurtosis (SE)	K-S
PPA	1	.76**	.83**	3.84±.02	3.86	-.07 (.11)	-.51 (.22)	.037 p=.119
MSE		1	.82**	3.79±.03	3.84	-.05 (.11)	-.69 (.22)	.050 p=.006
PSA			1	3.58±.03	3.57	.03 (.11)	-.12 (.22)	.039 p=.070

Note. PPA: Problem posing attitude, PSA: Problem solving attitude MSE: mathematical self-efficacy; SE=Standard error; K-S=Kolmogorov-Smirnov Normality test; **:Correlation is significant at 0.01 level.

When Table 1 is examined, it is seen that the average scores of the PPA ($\bar{X}$=3.84), PSA ($\bar{X}$=3.79) and MSE ($\bar{X}$=3.58) variables of the students are between 3.40 and 4.20 according to the value range table. Accordingly, it can be said that the PPA, PSA and MSE scores of the students are high. Whether the variables in the model were suitable for normal distribution were examined by skewness-kurtosis values and K-S normality test. Although the K-S test result was significant for the MSE variable, it was decided that there was no excessive deviation from the normal, taking into account that all skewness-kurtosis values were in the range of (–1, +1) (Table 1).

Pearson Product Moments Correlation Coefficient was calculated to determine the direction and level of the relationship between students' PPA, PSA and MSE. Positive between PPA and MSE ($r = .76$, $p < .01$), similarly between PSA and MSE ($r = .82$, $p < .01$), and between PPA and PSA ($r = .83$, $p < .01$) significant high level of correlation was found.

In order to determine the mediating role of the variable MSE, the model without MSE was tested (Figure 2). In the model without MSE, the total effect of PPA on PSA was obtained as B=2.57 (β= .92, $p < .01$). The coefficients for the detailed model are given in Appendix 1.

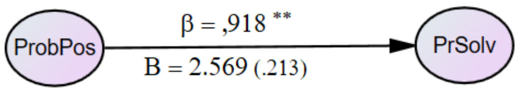

Figure 2. The total effect of PPA on PSA (CMIN=452.304; DF=132; p=.000; RMSEA=.070)

In the model without MSE, the total effect of PPA on PSA was found to be significant. The unstandardized coefficients obtained after adding MSE to the model as a mediator variable are given in Table 2 and standardized coefficients are given in Figure 3. A detailed SEM model is given in Appendix 2 regarding the effect of PPA and MSE on PSA.

Tablo 2. Unstandardized regression coefficients of direct and indirect effect from PPA to PSA via Self-Efficacy

Path			Estimate (B)	SE	CR	p
SelfEff	<---	ProbPos	1.674	.146	11.460	<.001
PrSolv	<---	SelfEff	.839	.117	7.196	<.001
PrSolv	<---	ProbPos	1.262	.224	5.624	<.001

CMIN=543.749; DF=202; p=.000; CMIN/DF=2.692; RMR=.047; GFI=.900; AGFI=.874; CFI=.902; RMSEA=.059 (90%CI= .053;.065).

The mediating role of MSE in the effect of PPA on PSA was examined in three stages. As seen in Figure 2, the total effect of PPA on PSA is B =2.57 (β = .92, $p < .01$) significant (Hyp. 1). When Figure 3 is examined, the direct effect of PPA on the mediating variable MSE is B = 1.67, which is significant. (β = .89, $p < .01$) (Hyp. 2).

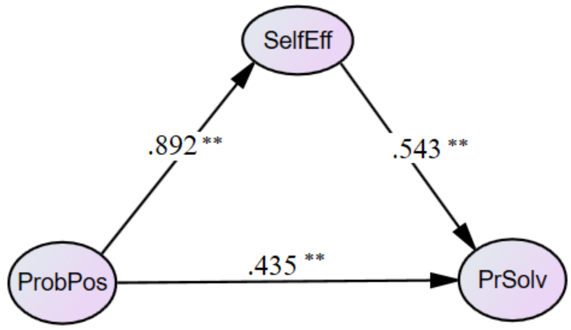

Figure 2. The effect of PPA and mediator variable together on PSA

The direct effect of the mediating variable MSE on PSA is also significant (β = .54, p < .01) (Hyp. 3). When PPA and MSE (mediator) are added to the model at the same time (Hyp. 4), the effect of PPA on PSA (β = .44, p < .01) decreases but remains statistically significant. From here, it can be said that MSE is the mediating variable in the relationship between PPA and PSA. The indirect effect of PPA on PSA through the mediating variable is B = 1.40 (β = .48). The Sobel Test was applied to determine whether this effect was significant. For the Sobel test, Z=3.695 (p < .01) was found to be significant. According to this result, MSE plays a partial mediator role between PPA and PSA. The values related to the effects between the variables in the model are summarized in Table 3.

Tablo 3. The Direct and Indirect Effects of PPA on PSA

Effect	**Path**	**Unstandardized Regression Weight**	**Standardized Coefficient (β)**	**S.Error**
Direct Effect	PSA <--- PPA	1.262	.435	.224
Indirect effect	PSA <--- MSE <--- PPA	1.404	.484	
	MSE <--- PPA	1.674	.892	.146
	PSA <--- MSE	.839	.543	.117
Total effect	PSA <--- PPA	2.569	.918	.213

PPA: Problem posing attitude, PSA: Problem solving attitude MSE: mathematical self-efficacy

As a result, the effect of PPA on PSA decreased after MSE was added to the model as a mediator variable (β = .92 in the absence of MSE). After adding MSE as a mediator variable, the effect of PPA on PSA decreased to β = .44. However, it remained statistically significant (p < .01). Therefore, it cannot be said that MSE is a complete mediator. Sobel Test was performed to determine whether the decrease was significant. According to this result, MSE is the partial mediator.

Some fit indices of the model were obtained as follows: CMIN=543.749; DF=202; p=.000; CMIN/DF=2.692; RMR=0.047; GFI=0.900; AGFI=0.874; CFI=0.902; RMR=0.047; RMSEA=0.059; 90% confidence interval for RMSEA (0.053, 0.065). According to these results, the model-data fit is at an acceptable level.

Conclusion and Discussion

In this study, the relationships between middle school students' attitudes towards mathematical problem posing, attitude towards problem-solving, and perception of mathematics self-efficacy were examined. Findings showed that: 1) Hypothesis 1 was accepted, i.e., the direct effect of PPA on PSA is positive and statistically significant. 2) Hypothesis 2 was accepted, i.e., the effect of PPA on MSE is positive and statistically significant. 3) Hypothesis 3 was accepted, i.e., the effect of MSE on PSA is positive and statistically significant. 4) Hypothesis 4 was rejected, i.e., after controlling the MSE, the relationship between PPA and PSA is decreased but remained statistically significant. Besides, this decrease was found to be significant according to the Sobel test. From this it can be said that MSE is not the complete mediator in the relationship between PPA and PSA. Accordingly, MSE plays a partial mediator role in its effect from PPA to PSA.

Innovative movements are carried out in mathematics teaching programs in order to strengthen teaching and to associate it with real life. It is seen that the primary school mathematics curriculum (MoNe, 2018) in practice in Türkiye focuses on teaching mathematics with a problem-solving approach, but not enough attention is given to problem-posing activities and achievements. Emphasizing the same issue, Ahmad and Zanzali (2006) state that the development of problem-solving skills is at the center of the school curriculum and although it has such positive effects, problem posing skills remain limited. While in school mathematics students are not asked to pose many problems throughout their educational experience, teachers often focus on their students' problem-solving. With the problem-solving-based mathematics teaching approach in the classroom environment, students can only gain solving problems in the textbook (routine problems) and cannot be a helpful tool in solving problems they may encounter outside of school (non-routine problems). Therefore, it can be thought that the problem posing experiences of middle school students are similar and limited, and in this case, negative attitudes may develop. On the other hand, students who constantly experience problem-solving in lessons develop positive attitudes. However, students can develop different and flexible mathematical thinking, reasoning, association, etc. By using their skills in the problem-solving process, they will gain better solving skills (routine and non-routine problems) that they may encounter. Problem posing is an important strategy for students to realize mathematical situations, understand mathematics, improve their own learning, and think about solving the problems they pose. Therefore, the knowledge and skills gained through problem posing will improve attitude and self-efficacy in a positive way. It has been reported in the literature that problem posing has a positive effect on attitude and self-efficacy (Akay & Boz, 2010; Brown & Walter, 2005), students' learning experiences in math problems will improve their positive attitudes towards the subject and increase their confidence in math skills (Zakaria & Ngah, 2011).

A remarkable result reached in this study is that students' problem posing attitudes are at a high level. Having higher attitudes towards problem posing not only encourages students to explore and understand problem situations better, but also helps them learn advanced problem-solving strategies (Cai & Hwang, 2003) and apply these strategies effectively in the problem-solving process. In this way, students' self-efficacy perceptions will be improved, and their mathematics achievement will increase. In addition, in the current study, a highly significant relationship was found between problem posing attitude and problem-solving attitude and self-efficacy. The online application of measurement tools may have been effective in this result. In the literature, there are studies in which students' problem posing attitudes are positive and high in relation to problem posing in mathematics (Katrancı & Şengül, 2019). In addition, in some studies that argue the opposite, middle school students have low problem posing skills (Ahmad & Zanzali, 2006; Özgen et al., 2017; Zakaria & Ngah, 2011) and there is no relationship between problem posing skills and problem-solving attitudes (Zakaria & Ngah, 2011) have been reported. On the other hand, in the current study, it is considered as an expected situation that students' problem-solving attitudes and self-efficacy perceptions are high. The result obtained supports the findings of the studies in the literature (Katrancı & Şengül, 2019; Zakaria & Ngah, 2011). These attitudes must be maintained in order for students to be successful in mathematics lessons.

In the literature according to the findings of a study conducted on secondary school students (Özcan & Gümüş, 2019), it was determined that mathematics self-efficacy played a mediating role in the effect of motivation and math anxiety on math problem solving performance. In another study, it was revealed that middle school students' attitudes and self-efficacy perceptions were related, and both were significant predictors for problem-solving (Nicolaidou & Philippou, 2007). In another study conducted on fifth graders in central China (Zhou et al., 2020), it was reported that the effect of teacher-student relationship on mathematical problem-solving ability, self-efficacy was played mediated role. It is possible to say that our findings in this study expand this mediating effect of self-efficacy.

Similarly, other findings of this study support the findings in the literature; mathematics self-efficacy sources have direct and indirect effects on problem-solving skills (Amri & Widada, 2018; Yurt & Sünbül, 2014), mathematics self-efficacy is a strong predictor of mathematical problem-solving (Pajares & Kranzler, 1995), there is a positive relationship between middle school students' problem posing attitudes and problem-solving attitudes in mathematics (Katrancı & Şengül, 2019), problem posing activities contribute to the effectiveness of students' problem-solving (Xie & Masingila, 2017), mathematics attitudes and self-efficacy (Akay & Boz, 2010). Likewise Chen et al., (2015) reported that problem posing has a positive effect on problem-solving in mathematics and on students' attitudes.

Problem posing and problem-solving in mathematics and raising students with high self-efficacy in these subjects are important strategies that educational institutions and teachers should focus on. Therefore, it is important to reveal the importance of attitudes in learning to pose and solve problems. If students have positive attitudes towards mathematics, they can pose problems (Zakaria & Ngah, 2011) and they tend to solve the mathematical problems they encounter.

This research has some limitations. The first concerns the method of data collection. In the current study, self-assessment tools were used to collect data, and this compromises internal consistency. Using more than one data collection method can remedy this deficiency. Another limitation is about the sampling method. In this study, data were collected from only one school with convenient sampling method. Although the size of the school reduces this limitation, it would be more appropriate to use a large number of schools to generalize the obtained statistics to the population (Frick, 1998).

This study was conducted with 5th, 6th, 7th and 8th grade students. Thus, the entire middle school period was covered; however, different findings might have emerged if each grade level had been separately included in the study. In addition to these limitations, a cross-sectional design was used in the present study. To overcome this limitation, future studies may use a long-term research design.

Finally, in this study, the mediating role of self-efficacy in the relationship between problem posing attitude and problem-solving attitude was examined. In future studies, besides self-efficacy, the mediating role of other variables such as academic achievement, gender, critical thinking in this relationship can be examined with the multiple mediation method.

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