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The relationships between middle school students' problem posing achievements and math problem solving attitudes: Fractions

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Abstract

In this study, it is aimed to investigate the relationships between middle school students' problem posing achievements and math problem solving attitudes about fractions topic. In addition to this, middle school students' problem posing achievements and math problem solving attitudes were examined in terms of gender and grade levels. For this purpose, the relational screening model was used in this study. The study group is consisted of 92 students who are studying in different grades in this middle school. "Problem Posing Form-PPF" and "Mathematics Problem Solving Attitude Scale-MPSAS" was used as data collection tools. It was determined that there was a positive and significant correlation at a moderate level between students' problem posing achievements and math problem solving attitudes. It was found that there was significant differences students' problem posing achievements according to gender and grade levels. There was no significant differences students' math problem solving attitudes according to gender and grade levels.

Keywords: Problem posing; problem solving attitude; relationships; fractions.

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1. Introduction

What kinds of ideas do students in general need to think about problem posing and problem solving? And how can we address these important matters? I have sought to engage my students in intellectual activities. This article discusses relationships between problem posing and mathematics problem solving attitudes. At this point, what is problem solving and problem posing?

Polya (1957) stated that problem solving means escaping the situation without difficulty. According to Silver (1994) problem solving is the elimination of confusion in the human mind and is the need to think (Cakmak, 2003) and is defined as the heart of mathematics education (Dede & Yaman, 2005). Similarly, problem posing lies at the heart of mathematical activity and is generally recognized as an important goal of mathematics learning and teaching (Crespo, 2003; Crespo & Sinclair, 2008). Problem posing can be defined as the reformulation of problems, as well as the generation of new problems and mathematical questions (Silver, Mamona-Downs, Leung & Kenney, 1996). Problem posing is active learning task that is important for students to develop and requires students to take a much more active role and to be responsible for their own learning but students do not have much practice developing their own problems (Nardone & Lee, 2011).

Stoyanova and Ellerton (1996) reported that every problem posing situation can be classified as free, semi-structured and structured. In free problem posing (FPP), students are asked to generate a problem from a given or naturalistic situation. Some directions may be given to students. In semi-structured problem posing (SSPP), students are given an open situation and to complete it by applying knowledge, skills and relationships from their previous mathematical experiences. Students might be asked to pose problems from equations or pictures (Stoyanova, 2003). In structured problem posing (SPP), problem posing activities are based on a specific problem. In this study, all of these problem posing activities are used in and wanted to pose problems about fractions topic from the students.

Many researchers argue that problem posing ability might be affected by problem solving ability. Problem posing improve students problem solving skills (Abu-Elwan, 2002; Barlow & Cates, 2006; Cai & Hwang, 2002). The results have shown a positive relation between problem solving ability and problem posing (Cai, 1998; Cai & Hwang, 2002; English, 1998). Brown and Walter (2005) and English (2003) argue that problem posing is closely linked to the problem solving ability. Silver and Cai (1993) found that a strong positive relationship between middle school student' problem posing abilities and problem solving. Additionally, Ellerton (1986) reported mathematically "able" students are also able to generate problems. Problem posing contributes to enhancing students' ability to solve mathematical problems (Lavy & Shriki, 2010). Moreover, problem posing reveals the attitudes the problem poser brings to a given situation (Toluk-Ucar, 2009). Activities related to problem posing may also have a positive influence on students' attitudes towards mathematical problem solving (English, 1997; Silver, 1994; Verschaffel, Greer & De Corte, 2000) and in contrast to traditional problem solving methods reduces anxiety and increases positive attitudes toward mathematics (Nicolaou & Philippou, 2004).

For these reasons in this study, it is aimed to investigate the relationships between middle school students' problem posing achievements and maths problem solving attitudes about fractions context. In addition to this, middle school students' problem posing achievements and math problem solving attitudes were examined in terms of gender and grade levels. In this regard, the answers of the following questions were searched.

About the fractions concept, middle school students';

1. Is there a significant relationship between problem posing achievements and math problem solving attitudes?
2. Is there any differences problem posing achievement according to the gender?
3. Is there any differences problem posing achievement according to the grade levels?
4. Is there any differences math problem solving attitude according to the gender?

5. Is there any differences math problem solving attitude according to the grade levels?

2. Method

2.1. Research method and study group

This study was designed based on relational screening model. Relational screening model aims to identify the relationship between two or more variables (Karasar, 2003). Study group was determined according to purposive sampling method, which is a non-probability and non-random sampling method (Buyukozturk, Kilic-Cakmak, Akgun, Karadeniz & Demirel, 2011), and is composed of 14 strategies (Patton, 1990). Convenience sampling method which helps select the most accessible sample to study on (Ravid, 1994) was used as the sample selection method. Within this context, the study group consisted of 92 students studying in different grades in a public school in Izmit district of Kocaeli province. Distribution of the study group is presented in Table 1.

Table 1. Study group

	5th Grade	6th Grade	7th Grade	8th Grade	**Total**
Female (F)	9	12	14	11	46 (%50)
Male (M)	12	12	10	12	46 (%50)
Total	21	24	24	23	92

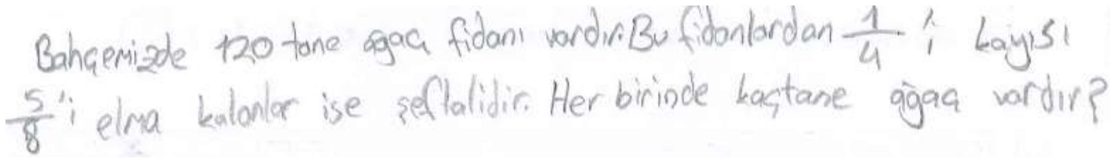
There were 46 female (50%) and 46 male students (50%) in the study group. It was composed of 92 students. 21 (22.82%) of them were 5th graders, 24 (26.09%) of them were 6th grades, 24 (26.09%) of them were 7th graders and 23 (25.00%) of them were 8th graders.

2.2. Data collection tools and data collection

The study used two data collection tools, namely "Problem Posing Form (PPF)" to identify problem posing achievements of middle school students and "Mathematics Problem Solving Attitude Scale (MPSAS)" to measure problem solving attitudes of students. All the data were collected during the spring semester of the academic year 2014/2015. The students had one class hour (40') to complete the data collection tools.

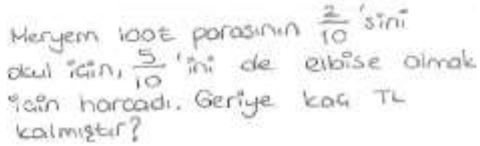
2.2.1. Problem posing form (PPF)

This form was designed by the researchers to identify the students' problem posing achievements in fractions topic. PPF consisted of three parts. The first part aimed to define the students' free problem posing achievements. The second and third parts were aimed to define the students' semi-structured problem posing and structured problem posing achievements, respectively. Two additional questions were directed to students to learn their grade levels and gender. Some of the examples obtained from PPF are given below (e.g. 5th grade S1= 5th grade student number 1).



There are 120 young trees in our garden. 1/4 of them are apricot trees, 5/8 of them are apple trees and the rest are peach trees. How many of each type of trees are there in the garden?

Figure 1. 5th grade S7

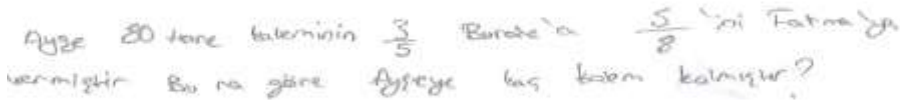


Meryem had a total of 100 liras. She spent 2/10 of her money for school supplies and 5/10 to buy a dress. How much money is left?

Figure 2. 6th grade S12

Nilgün had 2 liters of lemonade. Her friends Zeynep, Buket and Yaprak brought her 1/8 L, 2/8 L and 4/16 L of lemonade, respectively. How many liters of lemonade will Nilgün have in the end?

Figure 3. 7th grade S4



Ayşe gave 3/5 of her 80 pens to Burak and 5/8 of them to Fatma. According to this, how many pens would be left over for Ayşe?

Figure 4. 8th grade S2

2.2.2. Mathematics problem solving attitude scale (MPSAS)

This scale was developed by Canakci and Ozdemir (2011) to measure the students' mathematics problem solving attitudes. The scale, which consists of 19 items, involves two dimensions, namely enjoyment and teaching. The reliability coefficient of the whole scale was 0.848. As to the reliability coefficients of the dimensions, they were 0.869 and 0.777, respectively. First of all, Cronbach's alpha reliability was calculated for the whole scale, and it was found to be 0.823. Cronbach's alpha reliability for the enjoyment dimension was calculated to be 0.805 while it was 0.839 for the teaching dimension. If a reliability coefficient is 0.70 or higher, it is considered reliable enough for test scores (Buyukozturk, 2012), thus the calculated reliability coefficients were considered adequate, and the scale proved to be applicable for the study. Besides, confirmatory factor analysis was also conducted on the scale. The results are given in Table 2.

Table 2. MPSAS-confirmatory factor analysis

Indexes	Value	Goodness of fit
N	92	
X^2/sd	1,41	Perfect fit (Tabachnich & Fidell, 2001)
NNFI	,90	Good fit (Thompson, 204)
CFI	,91	Good fit (Sumer, 2000)
RMSEA	,07	Good fit (Steiger, 2007)

Garver and Mentzer (1999) stated that, after analyses are completed, it is sufficient to provide RMSEA, CFI and NNFI fit indexes. Within this context, the results of the confirmatory factor analysis are displayed in Table 2, and it is seen that all fit indexes are at sufficient levels.

2.3. Data analysis

Initially, the obtained 95 data collection tools were examined. In the examination, three data collection tools were excluded from the analysis process. Of them, one was from the 5th grade and two were from the 8th grade. Accordingly, analysis procedures were conducted on the remaining 92 data (form and scale).

Researchers used the "Rubric for Evaluating Problem Posing (REPP)", which was developed by Kaba and Sengul (2016), to evaluate the data obtained from PPF and they conducted their evaluations separately. Pearson's coefficient of correlation between the evaluation results of the two experts was found to be ".88". Furthermore, data obtained from PPF were re-evaluated by the first rater three weeks after the initial evaluation; and the intra-rater correlation coefficient between the evaluation results was found to be ".92". In this regard, reliability of the rubric was between 0.70 and 1.00, which indicated a high level of relationship (Buyukozturk, 2012) and thus, the rubric was considered to be suitable for the evaluation of the data obtained from PPF. The first researcher included the second evaluation results in the analysis as the students' achievement in problem posing processes. The average of the scores from all the tree parts of the form were assessed as the students' general problem posing achievements.

Since the group size was above 50, the data obtained from PPF and MPSAS were assessed by means of Kolmogorov-Smirnov (K-S) test to understand whether they followed a normal distribution or not (Buyukozturk, Cokluk & Koklu, 2010). Analyses indicated that the total scores from MPSAS followed a normal distribution, while dimensions of the scale and the form data did not follow a normal distribution. On the strength of this fact, the relationship between the variables was explained based on Spearman-Brown correlation.

At the end of the normality analyses, it was considered to be appropriate to use non-parametric methods to find answers to the second and third research questions. Within this context, analyses based on gender were conducted via Mann-Whitney U test and analyses based on the grade variable were conducted via Kruskal-Wallis test. Using parametric methods was convenient to find answers to the fourth and fifth research questions since the data followed a normal distribution. Under the circumstances, the analyses based on gender were conducted via independent samples t-test and analyses based on the grade variable were conducted via One-Way ANOVA test. Significance levels were taken to be ".05" in all the analyses and these analyses were conducted using the SPSS 17.0 program. Confirmatory factor analysis of MPSAS, on the other hand, was conducted via LISREL 8.7.

3. Results

The first research question was defined to be: "*Is there a significant relationship between problem posing achievements and math problem solving attitudes?*" All the relationships were assessed through Spearman-Brown correlation coefficient, and the results are given in Table 3.

Table 3. Problem posing & problem solving attitude

Correlations	r	p	N	Values
FPP-MPSAS	,120	,253	92	p > ,05
SSPP-MPSAS	,282	,006	92	p < ,05
SPP-MPSAS	,176	,094	92	p > ,05
PP-MPSAS	,306	,003	92	p < ,05

In the light of Table 3, it is seen that there is not a significant relationship between the math problem solving attitudes and free problem posing and structured problem posing achievements of the middle school students (r_{fpp}= .120; p> .05; r_{spp}= .094; p> .05). On the other hand, there is a significant relationship between the problem solving attitudes and general problem posing and semi-structured problem posing achievements of the students (r_{sspp}= .282; p< .05; r_{pp}= .306; p< .05).

A coefficient of correlation between 0.30 and 0.00 is considered to mean a low level of relationship (Buyukozturk, 2012), and therefore there is a positive and significant relationship at a low level between semi-structured problem posing achievement and attitude. A coefficient of correlation between 0.30 and 0.70 represents a moderate relationship between problem solving achievement and attitude (Buyukozturk, 2012). In this respect, it is seen that there is a positive and moderate relationship between general problem posing achievement and attitudes. The second research question was defined as: "*Are there any differences in problem posing achievements according to gender?*" The obtained data were evaluated via Mann-Whitney U test, and the findings are presented in Table 4.

Table 4. Problem posing & gender

FPP & Gender	N	Mean Rank	Sum of Ranks	U	p
Female	46	51,47	2367,50	829,50	,068
Male	46	41,53	1910,50		
SSPP & Gender	N	Mean Rank	Sum of Ranks	U	p
Female	46	52,43	2412,00	785,00	,028
Male	46	40,57	1866,00		
SPP & Gender	N	Mean Rank	Sum of Ranks	U	p
Female	46	50,57	2326,00	871,00	,088
Male	46	42,43	1952,00		
PP & Gender	N	Mean Rank	Sum of Ranks	U	p
Female	46	53,27	2450,50	746,50	,015
Male	46	39,73	1827,50		

In the light of Table 4, it can be said that free and structured problem posing achievements of the students do not exhibit any significant difference according to gender ($_{Ufpp}$=829.50; p= .068> .05; U_{spp}=871.00; p> .05.) If the mean ranks are taken into consideration, on the other hand, it is seen that the female students' free and structured problem posing achievements are higher than those of the male students.

It can also be said that there is a significant difference between the female and male students in terms of semi-structured and general problem posing achievements (U_{sspp}=785.00; p= .028< .05; U_{pp}=746.50; p< .05). The third research question was defined as "*Are there any differences in problem posing achievements according to grade levels?*" The obtained data were evaluated through Kruskall-Wallis test, and the findings are presented in Table 5.

Table 5. Problem posing & grades

FPP & Grade	N	Mean Rank	sd	X^2	p	Significant Differences
5	21	49,52				
6	24	45,13	3	1,014	,798	-
7	24	48,83				
8	23	42,74				
SSPP & Grade	N	Mean Rank	sd	X^2	p	Significant Differences
5	21	38,54				
6	24	51,27	3	2,859	,414	-
7	24	47,33				
8	23	47,89				
SPP & Grade	N	Mean Rank	sd	X^2	p	Significant Differences
5	21	25,31				
6	24	51,33	3	24,800	,000	5-6, 7, 8
7	24	57,13				
8	23	49,72				
PP & Grade	N	Mean Rank	sd	X^2	p	Significant Differences
5	21	29,88				
6	24	52,02	3	11,418	,010	5-6, 7, 8
7	24	54,58				
8	23	47,48				

It is seen in Table 5 that free and semi-structured problem posing achievements of the students do not show significant differences according to grade levels ($X^2 = 1.014$; p= .798> .05; $X^2 = 2.859$; p= .414> .05). However, structured and general problem posing achievements exhibit significant differences according to grade levels ($X^2 = 1.014$; p= .798> .05; $X^2 = 2.859$; p= .414> .05).

The obtained differences were evaluated via Mann-Whitney U test and it was discovered that the fifth grade students, when compared to their peers in other grades, exhibit significant differences in terms of their structured and general problem posing achievements. The fourth research question was defined as "*Are there any differences in math problem solving attitudes according to gender?*" The obtained data were evaluated through independent samples t-test, and the results are presented in Table 6.

Table 6. Problem solving attitude & gender

Gender	N	$\bar{X}$	S	sd	t	p
Female (F))	46	67,4130	11,36	90	1,275	,206
Male (M)	46	64,0217	14,01			

It is seen in Table 6 that the mathematics problem solving attitudes of the middle school students do not exhibit significant differences according to gender ($t_{90} = 1.275$; p > .05). Besides, it is seen that the female students' mathematics problem solving attitudes ($\bar{X}$=67.4130) are more positive than those of male students ($\bar{X}$=64.0217). The last research question was defined as "*Are there any differences in math problem solving attitudes according to grade levels?*" The data were evaluated via One-Way ANOVA, and the obtained findings are given in Table 7.

Table 7. Problem solving attitude & grades

	Sum of squares	sd	Mean square	F	p	Significant Differences
Between groups	249,551	3	83,184			
Within groups	14669,101	88	166,694	,499	,684	-
Total	14918,652	91				

It is seen in the light of Table 7 that the middle school students' mathematics problem solving attitudes do not exhibit significant differences according to grade levels ($F(3.91)=.499$; $p > .05$). In other words, the students' problem solving attitudes do not vary by grade level.

4. Conclusions, Implications and Recommendations

According to the findings of the present study, which attempted to answer the question "*Is there a relationship between middle school students' problem posing achievements and math problem solving attitudes?*", it is clear that there is a significant relationship between semi-structured and general problem posing achievements and problem solving attitudes; however, there is not any significant relationship between free and structured problem posing achievements and mathematics problem solving attitudes. In the light of this finding, it is possible to say that there is a mid-level positive relationship between problem posing achievements and mathematics problem solving attitudes of middle school students. Grundmeier (2002) found that there is no correlation between students' attitudes towards mathematics and problem posing abilities. Students gain experience with problem posing, and their attitude towards mathematics will shed on their problem posing ability. Zakaria and Ngah (2011) found no correlation between students' problem posing ability and students' attitudes towards problem solving. Guvercin, Cilavdaroglu and Savas (2014) said that problem posing activities develop positive attitudes toward mathematics. Brown and Walter (2005) said that problem posing may increase students' positive attitudes. Similarly, Akay and Boz (2010) specified that problem posing can have a positive impact on attitudes. In this context, more research about the relationship between problem posing and problem solving attitudes must be undertaken.

Another finding of the study indicates that students' semi-structured and general problem posing achievements significantly vary by gender while their free and structured problem posing achievements do not exhibit any significant difference. Since there are not any studies conducted in this area, there is a need for new studies so that these results can be interpreted. In this way, it will be possible to have a clear understanding of whether middle school students' problem posing achievements vary by gender or not.

Students' structured and general problem posing achievements exhibit significant differences according to grade levels, while free and semi-structured problem posing achievements do not show significant differences by grade level. Fifth grade students, when compared to their peers in other grades, have significant differences in terms of their structured and general problem posing achievements. According to Sharifah and Zanzali (2006) students' ability to pose problems is still limited. It can be recommended that future studies explore the reasons for this result.

Female students' attitudes towards mathematics problem solving were found to be more positive than those of male students, while mathematics problem solving attitudes were revealed not to exhibit any significant differences by gender. This result is compatible with the findings reported by Kasap (1997) and Canakci (2008). In Mohd and Mahmood (2011), the findings show that there is no significant difference between attitudes towards problem solving by gender. There are also several other studies reporting no significant difference in students' attitudes towards problem solving according to gender (Effandi & Normah, 2009; Popoola, 2002).

Another result of the study is that students' mathematics problem solving attitudes do not show significant differences according to grade levels. This finding is supported by Canakci (2008), but is not consistent with those of Furner and Berman (2003). It can also be recommended that the reasons for the differences among these findings are explored in future research.

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