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THE RELATIONSHIP BETWEEN MATHEMATICS MOTIVATION AND MATHEMATICS PROBLEM-SOLVING SKILLS OF PRIMARY SCHOOL STUDENTS

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Abstract

This study investigated the relationship between primary school students' mathematics motivation and problem-solving skills in mathematics. A total of 429 students were selected through convenience sampling, using a relational survey model. Data were collected using the Mathematics Problem-solving Achievement Test and the Mathematics Course Motivation Scale using the relational survey model. The research results showed that fourth-grade primary school students' mathematics problem-solving scores were at the 'Needs Improvement' level although they have high motivation in mathematics. Secondly, their motivation towards mathematics did not differ regarding teacher turnover and the mother's educational status while, but it significantly differs concerning the father's education status. Namely, those whose fathers are graduates of primary school and university performed better than those whose fathers are graduates from middle school. It was also found that their mathematics problem-solving achievement scores did not differ regarding teacher turnover but differed significantly with respect to mothers' educational status (in favour of university graduates compared to middle school and high school graduates; in favour of primary school graduates compared to high school graduates) and fathers' educational status (in favour of university graduates compared to high school graduates). This study found a weak but statistically significant positive relationship between their motivation towards mathematics and problem-solving skills. Lastly, this study revealed that the mathematics motivation of fourth-grade primary school students accounted for 7% of the increase in mathematics problem-solving success scores.

Keywords: Mathematics, motivation, problem solving, primary school.

INTRODUCTION

Mathematics, rooted in the Greek term "máthema" (science, knowledge, and learning) equip individuals with essential skills, such as analytical thinking and problem solving (Koşar & Yılmaz, 2020). Although it plays a critical role in the development of children's academic and life skills (MoNE, 2018), some students may find mathematics boring and abstract and develop a negative perception (Hadi, Herman, & Hasanah, 2018). Tahiroğlu and Çakır (2014) proposed the concept of "mathematics motivation" for students to develop positive attitudes towards mathematics and enhance students' engagement.

The path to success in mathematics is linked to effective problem solving and NCTM (2000) recognizes problem solving as the foundation of school mathematics. In this context, it is of great importance to understand the factors affecting primary school students' problem-solving success, especially the role of mathematics motivation.

Many studies in the literature are based on the examination of mathematics motivation, parameters affecting mathematics achievement and factors affecting problem-solving skills. In a study conducted by Bozkurt and Bircan (2015), the relationship between mathematics motivation and academic

achievement of 5th-grade students was investigated. A significant relationship was found between learning belief, self-efficacy, goal orientation and subject value and mathematics achievement. Türk (2021) examined the relationship between mathematics anxiety and motivation levels of 4th-grade primary school students and mathematics course achievement. It was concluded that there was a low-level relationship between intrinsic motivation, a motivation and mathematics achievement. Karaman and Mutluer (2023) examined the mathematics motivation of primary school 2nd, 3rd and 4th-grade students in terms of various variables. While a significant difference was found between mathematics motivation level and mother's education level, no significant difference was found with father's education level and gender. Baş and Şahin (2024) investigated the relationship between mathematics motivation, anxiety and self-efficacy levels of 3rd and 4th-grade primary school students. It was found that students had high levels of intrinsic motivation and self-efficacy, moderate levels of extrinsic motivation, and low levels of amotivation and anxiety. In'am and Sutrisno (2021) showed that the collaborative learning model significantly increased the mathematics self-efficacy and motivation of 8th-grade students. Mamola's (2022) study found that online learning during COVID-19 negatively affected Filipino students' mathematics motivation and self-efficacy, not anxiety.

Kesici and Aşılıoğlu (2017) investigated the effect of mathematics attitude, motivation, anxiety and stress levels of 8th-grade primary school students on mathematics achievement. Their findings showed that attitude, motivation and stress had a positive effect on mathematics achievement, while anxiety had a negative effect. Sarı and Ekici (2018) examined the effect of motivation, attitude and anxiety on mathematics achievement of 4th-grade primary school students. It was found that motivation had no significant effect, attitude had a positive effect, and there was a negative relationship between attitude and anxiety. Kaya (2019) examined motivation, self-regulated learning strategies and metacognitive awareness as factors predicting mathematics achievement of 7th-grade students. It was found that self-regulated learning strategies and motivation showed significant relationships with metacognitive awareness. Külünk Akyurt (2019) examined the relationship between mathematics motivation, achievement and anxiety of primary school 4th-grade students. It was found that there were significant relationships between mathematics achievement and motivation and anxiety. Özdemir (2021) examined the relationship between mathematics self-efficacy perception, motivation and anxiety of 8th-grade students. A positive relationship was found between self-efficacy and motivation, and a negative relationship was found between motivation and anxiety. Kara and Özkaya (2022) investigated the relationship between 8th-grade students' mathematics motivation, attitudes and achievement. It was found that there was a positive and moderately significant relationship between the three variables. Studies emphasize that the likelihood of success increases when students' mathematics motivation, especially intrinsic motivation, is high. It also indicates that mathematics motivation is multifaceted and depends on various factors, and these factors may have direct or indirect effects on mathematics achievement. Hence, this study focuses on the variables that may affect or be related to mathematics motivation.

Ergen (2020) examined the non-routine problem-solving skills of primary school 4th-grade students and observed that students had difficulty in problem-solving even if they performed arithmetic operations correctly. The study emphasizes that students' problem-solving strategies should be improved. Tayfur (2022) examined the relationship between four operations skills and problem-solving achievement of 4th-grade primary school students. A moderate, positive and significant relationship was found between four operation skills and problem-solving achievement. Ramnarain (2014) showed that teaching problem solving strategies improved the problem-solving achievement of disadvantaged high school students. The study emphasizes the significance of strategy instruction. Al Shabibi and Alkharusi (2018) examined the relationship between meta-cognitive skills and problem-solving skills of 5th-grade students. They found that students with high academic achievement also had high problem solving and meta-cognitive skills. Pohan et al. (2020) found that problem-based learning had a positive effect on learning motivation and problem-solving skills of 5th-grade students. Habtamu et al. (2022) found that collaborative problem solving positively affected 9th-grade students' motivation to learn

algebra. In general, although there is more evidence of a positive relationship between mathematics motivation and problem-solving skills, some studies do not support this relationship. In addition, it is seen that other variables are also effective on mathematics achievement and problem-solving skills. The above research results point to strategy use, metacognitive awareness and active learning environments rather than calculation for the development of problem-solving skills. It would be beneficial to include these elements in educational practices to increase mathematics achievement and strengthen mathematical thinking skills. Walle, Karp, and Bay-Williams (2021) state that problem solving is the heart of mathematics. Therefore, increasing mathematics achievement should be considered together with improving mathematics problem-solving skills. When this situation is evaluated together with the above studies pointing to the role of mathematics motivation in mathematics achievement, it shows that the relationship between mathematics motivation and mathematics problem-solving skills is an important issue that needs to be investigated.

Although many studies investigate the effect of mathematics motivation on mathematics achievement, it is observed that the number of studies in which this relationship is addressed especially at the primary school level and in the context of problem-solving skills is limited.

The main purpose of this study is to investigate in depth the relationship between mathematics motivation and mathematics problem-solving skills of 4th-grade primary school students. This study focuses on two main research questions: (1) Is there a significant relationship between mathematics motivation and problem-solving skills of 4th-grade primary school students? and (2) Does mathematics motivation significantly predict students' problem-solving skills? To answer these questions, a quantitative research method was adopted, and various analyses were conducted within the scope of this study.

Firstly, students' mathematics motivation and problem-solving levels were analyzed using descriptive statistics. Then, whether these variables differed in terms of demographic variables, such as teacher change status and parental education level were analyzed using parametric or non-parametric tests. Thus, the possible effects of demographic factors on motivation and problem-solving skills were analyzed

Finally, correlation analysis was used to determine the direction and strength of the relationship between mathematics motivation and problem-solving skills. Regression analysis was used to determine the predictive power of motivation on problem-solving skills. These analyses aim to provide more detailed information about the nature of the relationship between the two variables by revealing the magnitude and direction of the effect of motivation on problem-solving skills.

METHOD

In this section, the research model, population and sample, data collection tools and statistical analysis methods are discussed in detail.

Research Model

This study aimed to examine the relationship between mathematics motivation and mathematics problem-solving skills of 4th-grade primary school students. This study, which was conducted using the survey model, one of the quantitative research designs, according to Creswell (2014), the survey model allows for the quantitative description of the tendencies, attitudes or opinions in the general population through a sample selected from a population.

In this context, this study examined whether students' mathematics motivation levels and mathematics problem-solving skills differed in terms of demographic characteristics and the relationship between them, and the relationship between these variables was analyzed with the relational screening model.

Universe and Sample

The study population of this research included 4th-grade students in Kahramanmaraş province. The sample consisted of 429 primary school 4th-grade students studying in public schools in Onikişubat

district of Kahramanmaraş province in the 2023-2024 academic year who did not participate in the achievement test development process. Sample selection was carried out by convenient sampling method, which is one of the non-random sampling methods. As emphasized by Gurbetoğlu (2018), convenience sampling method requires the selection of easily accessible units due to labour, cost and time constraints. In this study, convenience sampling method was preferred due to these limitations. The distribution of the population and sample group of this study is given in Table 1.

Table 1. Distribution of demographic characteristics of the participants.

Variables	n	%
Mother Education Level		
Primary School	87	20.28
Middle School	64	14.92
High School	133	31.00
University and Above	96	22.38
Unspecified	49	11.42
Father Education Level		
Primary School	46	10.72
Middle School	54	12.59
High School	151	35.20
University and Above	153	35.66
Unspecified	25	5.83
Teacher Replacement Status		
Did not change	260	60.61
Two Teachers	123	28.67
Three Teachers and More	46	10.72

Table 1 shows the distribution of demographic characteristics of the participants. There were 429 participants in total. When the education level of the mothers of the participants was analyzed, the rate of mothers who were high school graduates was the highest with 31%. This is followed by university and above graduates 22.38%, primary school graduates 20.28%, secondary school graduates 14.92% and those whose educational status could not be reached 11.42%. When the education level of the fathers was analyzed, the proportions of high school graduates and university and above graduates were almost the same. These were followed by secondary school graduates (12.59%), primary school graduates (10.72%) and those whose educational status could not be reached (5.83%). Finally, in terms of changing teachers, 60.61% of the participants did not change teachers. While the rate of those who changed two teachers was 28.67%, the rate of those who changed three or more teachers was 10.72%.

Data Collection Tools

Three data collection tools were used in this study.

- Demographic Information Form
- Maths Problem-solving achievement Test
- Mathematics Motivation Scale (Tahiroğlu & Çakır, 2014)

The Demographic Information Form prepared by the researcher includes variables, such as the educational level of the parents of the students in the study group and the status of changing teachers.

The Mathematics Problem-solving achievement Test was developed by the researcher and consists of 37 items. The test items were determined based on the learning outcomes of the Numbers and Operations learning area in the Ministry of National Education (2018) Primary Mathematics Programme. Within the scope of the test, gains related to the sub-learning areas of Natural Numbers, Four Operations in Natural Numbers and Fractions were measured with multiple-choice questions. An outcome-oriented specification table was created, and the test was prepared so that each outcome had at least two questions. The test was examined by two experts in classroom and mathematics education, two classroom teachers each with 20 years of professional experience, and one measurement and evaluation specialist. Revisions were implemented in accordance with their expert recommendations.

The pilot application of the test was carried out with 36 4th-grade students in the 2023-2024 academic year. Then, the 64-question test was applied to 317 4th grade students in Onikişubat district of Kahramanmaraş province, but 4 students could not be included in the test process for various reasons. The data were analyzed using SPSS statistical software and item strength and discrimination indices were calculated and shown in Table 2.

Table 2. Item difficulty index and item discrimination power index values of trial mathematics problem solving achievement test.

Question Numbers	Item Difficulty Index (Pj)	Item Discrimination Power Index (rjx)
1	.78	.32
2	.82	.27
3	.77	.36
4	.51	.44
5	.31	.40
6	.75	.30
7	.89	.35
8	.88	.46
9	.86	.41
10	.53	.56
11	.72	.50
12	.50	.43
13	.64	.48
14	.71	.51
15	.76	.50
16	.57	.63
17	.62	.57
18	.75	.56
19	.78	.51
20	.51	.54
21	.72	.52
22	.69	.52
23	.54	.54
24	.75	.54
25	.72	.54
26	.44	.36
27	.57	.55
28	.55	.56
29	.54	.62
30	.48	.49
31	.53	.58
32	.55	.53
33	.39	.33
34	.73	.48
35	.90	.35
36	.46	.40
37	.28	.30
38	.55	.50
39	.33	.39
40	.58	.49
41	.50	.52
42	.56	.45
43	.33	.35
44	.42	.21
45	.32	.32
46	.40	.44
47	.53	.57
48	.49	.57
49	.38	.45
50	.31	.44
51	.42	.49
52	.43	.44

Table 2 (Continued). Item difficulty index and item discrimination power index values of trial mathematics problem solving achievement test.

Question Numbers	Item Difficulty Index (Pj)	Item Discrimination Power Index (rjx)
53	.27	.32
54	.24	.27
55	.21	.11
56	.21	.09
57	.28	.04
58	.29	.13
59	.29	.31
60	.31	.37
61	.26	.39
62	.33	.36
63	.23	.08
64	.18	.36

While determining the final achievement test, item strength indices and discrimination values were considered and 37 of 64 items were included in the final test. Of the 37 questions in the final test, 19 were routine problems and 18 were non-routine problems, and the correct answers given by the students were evaluated as 1 point and the wrong answers were evaluated as 0 points. The KR-20 reliability coefficient of the test was .91.

In addition, the Mathematics Course Motivation Scale was developed by Tahiroğlu and Çakır (2014) and used with permission. The scale, which consists of five sub-dimensions (Motivation for Being Appreciated; Motivation for Interests, Wants and Needs; Motivation for Developing Self-confidence; Motivation for Being Successful; Motivation for Goals) and is graded with a five- point Likert type, contains 32 items, and the range of points that can be obtained from the scale is between 32 and 160. While the Cronbach Alpha reliability coefficient of the related scale was .93, it was calculated as .91 in this study.

Data Collection

The data collection process was conducted in accordance with ethical rules and scientific methods. Firstly, permission was obtained from the developers of the scale used via e-mail, and then ethics committee approval was obtained from the authorised institution. In addition, official processes were completed by obtaining the necessary permissions from Kahramanmaraş Provincial Directorate of National Education.

The researcher interviewed school administrators and fourth grade teachers and informed them about the purpose and process of this study. The data collection process was carried out in the second semester of the 2023-2024 academic year. The application, each stage of which was carried out by the researcher, was completed during two 40-minute lesson hours in each class. This time was determined especially considering the fact that the maths problem-solving achievement test takes more time and it was sufficient in all classes where data were collected.

Data Analysis

The research data analyzed with the SPSS programme were examined whether the mathematics problem-solving achievement test scores and mathematics motivation scores were normally distributed in the subgroups of demographic variables. Accordingly, the skewness and kurtosis values of the dependent variables in each subgroup of the independent variables were determined. These values are presented in Table 3.

Table 3. Normality analyses of mathematics problem solving achievement scores.

	Problem Solving		Motivation	
	Skewness	**Kurtosis**	**Skewness**	**Kurtosis**
Mother Education Level				
Primary School	.369	-.790	-1.161	2.376
Middle School	.649	-.201	-1.253	2.327
High School	1.002	.477	-1.061	1.787
University and Above	.033	-1.055	-1.037	2.131
Unspecified	.699	.105	-1.487	4.141
Father Education Level				
Primary School	.627	-.205	-.922	.613
Middle School	.741	-.417	-.991	1.421
High School	.785	.136	-1.404	3.240
University and Above	.235	-1.033	-.949	1.168
Unspecified	.216	-.034	-.050	-1.011
Teacher Replacement Status				
Did not change	.573	-.521	-1.171	2.456
Two Teachers	.682	-.453	-1.304	2.103
Three Teachers and More	.554	-.369	-.353	-.819

As shown in Table 3, it was seen that the kurtosis and skewness values of the Maths problem-solving achievement test were in the range of +2-(-2) in all subgroups of demographic variables. According to the normal distribution criteria stated by George and Mallery (2010), this shows that the data are normally distributed. Therefore, it was deemed appropriate to use parametric tests in the analyses related to the mathematics problem-solving achievement test. In the same table, when the kurtosis and skewness values of the motivation scores were analyzed, it was found that at least one of the subgroups of the demographic variables had skewness and/or kurtosis values outside the +2-(-2) range. This situation indicates that motivation scores do not show normal distribution in at least one subgroup. Therefore, non-parametric tests were used in the analyses related to the motivation test. In the mathematics motivation scale scores where normal distribution was not provided, extreme values were determined by Boxplot graph for simple linear regression analysis. In the graph, seven outliers were below the lower limit line and these values were removed from the analysis and normal distribution was ensured. The presence of linearity between the variables, which is another assumption of simple linear regression analysis, was checked with the scatter diagram, and it was seen that there was a linear relationship between the variables. In addition, Levene's test was checked for the assumption of homogeneity of variances, and it was seen that the variances were homogeneous ($p \geq .05$).

Based on the assumption that the score ranges in the mathematics motivation scale were equal, arithmetic averages were calculated, and the results are presented in Table 4. Accordingly, the motivation scores of the participants were categorized as "Very Low, Low, Medium, High and Very High. "

Table 4. Evaluation range of arithmetic averages.

December	**Option**	**Motivation Level**
1.00-1.80	Completely Disagree	Very low
1.81-2.60	Disagree	Low
2.61-3.40	Moderately Agree	Centre
3.41-4.20	I agree	High
4.21-5.00	Completely Agree	Very High

Mathematics achievement test scores were graded based on the frequently asked questions guide prepared on the basis of the Ministry of National Education Measurement and Evaluation Regulation published in the official gazette dated 09.09.2023 and numbered 32304 and published by the Ministry of National Education (MoNE) (2023) and these grades are given in Table 5.

Table 5. Grades of achievement tests scores.

December	Option
0-54	Should be improved
55-70	Adequate
71-84	Good
85-100	Very good

In this study, the correlation analysis conducted to determine the relationship between the variables was evaluated according to the interpretation criteria suggested by Büyüköztürk (2012) and given in Table 6.

Table 6. Correlation analysis correlation coefficients and level.

Correlation coefficient	Relationship level
0- .30	Low
.31- .70	Centre
.71- .89	High
.90-1.00	Very high

As seen in Table 6, the relationship levels between the variables analysed were evaluated as "Low, Medium, High and Very High."

RESULTS

In this section, the findings showing the mathematics motivation and mathematics problem solving skill levels of 4th-grade primary school students, the differentiation of these two variables according to teacher change and parental education level, and the level of relationship between each other are presented.

Findings on mathematics motivation levels and mathematics problem-solving levels of 4th-grade primary school students

Information about students' mathematics motivation levels and mathematics problem-solving achievement scores are given in Table 7 respectively.

Table 7. Students' mathematics motivation levels and mathematics problem solving achievement scores.

	n	Mean	Dtd.Dev.	Min. Value	Max. Value
Maths Motivation	429	3.8770	.525	1.4375	4.8125
Maths Problem Solving Achievement Score	429	46.70	20.81	8.11	100

As presented in Table 7, it was seen that students' mathematics motivation levels are at the level of "high" (X= 3,8770), while their achievement scores for solving mathematical problems are at the level of "should be improved" (X= 46,70). Accordingly, it can be said that although students' mathematics motivation was high, their achievement scores in solving mathematical problems were low. This situation can be interpreted as an indication that maths problem-solving skills are affected by different variables besides motivation.

Findings of 4th-grade primary school students' mathematics motivation and mathematics problem-solving achievement scores related to teacher change status

The findings of mathematics motivation and mathematics problem-solving achievement scores related to teacher change status are given in Table 8 and Table 9, respectively.

Table 8. Kruskal Wallis H test result of mathematics motivation for teacher change status.

	Teacher Replacement Status	n	Rank Mean.	df	X^2	p
Maths Motivation	Did not change	260	208.23	2	2.089	.352
	Two Teachers	123	227.44			
	Three Teachers and More	46	220.00			

Kruskal-Wallis H Test was applied to determine whether mathematics motivation differed significantly according to the students' teacher change. As a result of the test, it was found that there was no significant difference between the groups (X^2 (df = 2, n = 429) = 2.089; p ≥ .05). Accordingly, it can be said that students' mathematics motivation does not differ significantly according to the number of teacher changes.

Table 9. One-Way Analysis of Variance (One-Way ANOVA) test results of mathematics problem solving achievement scores for teacher change status.

	Teacher Replacement Status	n	Mean	Std.Dev.	df	F	p	Significant Difference
Maths Problem Solving Achievement Score	Did not change	260	47.88	20.36	2/426	1.24	.288	-
	Two Teachers	123	45.48	21.65				
	Three Teachers and More	46	43.30	20.92				

One-factor analysis of variance was performed to determine the differentiation of students' mathematics problem-solving achievement scores according to teacher change status. As a result of the test, it was found that the difference between the group means was not significant ($F_{2/426}$=1.249; p≥.05). Accordingly, it can be said that students' mathematics problem-solving achievement scores do not differ significantly according to the status of changing teachers.

The findings of 4th-grade primary school students' mathematics motivation and mathematics problem-solving achievement scores related to their parents' education levels

The findings related to the change in mathematics motivation according to mother and father's education level are given in Table 10.

Table 10. Kruskal Wallis H test results of mathematics motivation related to mother and father education level.

	Education Level	n	Rank Mean.	df	X^2	p	Significant Difference
Mum	Primary School (A)	87	216.59	4	4.4818	.344	-
	Middle School (B)	64	202.34				
	High School (C)	133	204.35				
	University and Above (D)	96	236.22				
	Unspecified (E)	49	216.04				
Father	Primary School (A)	46	245.03	4	14.550	.006	D-B; A-B
	Middle School (B)	54	173.76				
	High School (C)	151	201.78				
	University and Above (D)	153	235.08				
	Unspecified (E)	25	205.80				

A: Primary school; B: Secondary School; C: High School; D: University and Above; E: Unspecified

The relationship between mathematics motivation and parental education level was analysed using the Kruskal-Wallis H Test. As a result of the test, it was observed that there was no significant difference between the groups in maternal education levels (X^2 (df = 4, n = 429) = 4.481; p≥.05), while there was a significant difference between the groups in father education levels X^2 (df = 4, n = 429) = 14.550; p≤.05). As a result of the pairwise comparison test, a significant difference was found when the mean ranks were compared between secondary school graduates and primary school graduates and between secondary school graduates and university and above graduates. This significant difference was in favour of fathers with primary school graduation - university and above graduation.

The findings regarding whether the mathematics problem-solving achievement scores of the students differed according to their mother and father's education level are given in Table 11.

Table 11. One-factor analysis of variance (One-Way ANOVA) test results of students' mathematics problem-solving achievement scores related to mother and father education level.

	Education Level	n	Mean	Std.Dev.	df	F	p	Significant Difference
Mum	Primary School	87	49.45	20.70	4/183.14	7.23	.000	A-C; D-B D-C; D-E
	Middle School	64	43.91	17.07				
	High School	133	40.80	19.56				
	University and Above	96	55.65	23.81				
	Unspecified	49	43.96	15.74				
Father	Primary School	46	46.35	19.08	4/109.55	8.16	.000	D-C
	Middle School	54	45.24	19.64				
	High School	151	40.52	17.96				
	University and Above	153	53.98	22.81				
	Not specified	25	43.35	16.74				

A: Primary school; B: Secondary School; C: High School; D: University and Above; E: Unspecified

One-factor analysis of variance was applied to determine the differentiation of students' mathematics problem-solving achievement scores according to their mother and father education level. As a result of the analysis, it was seen that there was no homogeneity of variance ($p \leq .05$). Thus, the Welch test was applied, and it was found that the difference between group averages was significant ($F_{4/183,14}=7.239$; $p \leq .05$). According to this, it can be said that the mathematics problem-solving achievement scores of the students differed according to the level of mother and father education. According to the results of the Games-Howell test, according to the results of maternal education level, a significant difference was found between mothers with primary school graduation and mothers with high school graduation in favour of mothers with primary school graduation, between mothers with university and above graduation and mothers with secondary school and high school graduation in favour of mothers with university and above graduation. According to the father's education level results, a significant difference was found between the university and above graduates and high school graduates in favour of the university and above graduates.

The relationship between mathematics motivation and mathematics problem-solving skills

Spearman Correlation Analysis was performed to determine the relationship between students' mathematics motivation and their mathematics problem-solving achievement scores. The findings related to the analysis are given in Table 12.

Table 12. The relationship between mathematics motivation and mathematics problem solving achievement scores.

		Maths Problem Solving Achievement Score
Maths Motivation	Spearman's rho	.256*
	p	.000
	n	429

* Correlation is significant at $p \leq .05$ level.

Spearman Correlation Analysis was applied to determine the relationship between mathematics motivation and mathematics problem-solving achievement scores. As a result of the analysis, a positive, weak ($r=.256$), significant ($p \leq .05$) relationship was found. Accordingly, students' mathematics motivation and mathematics problem-solving achievement scores increase significantly together with a weak relationship. This relationship is shown in Figure 1

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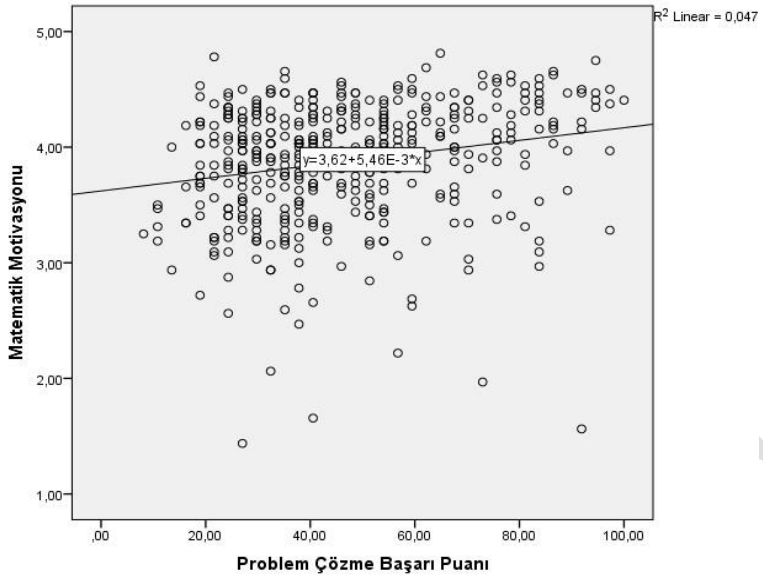

Figure 1. Maths problem solving achievement score

Mathematics motivation is a significant predictor of mathematics problem-solving skills

The results of the simple linear regression analysis for the prediction of students' mathematics problem-solving achievement scores are given in Table 13.

Table 13. Results of simple linear regression analysis for the prediction of mathematics problem solving achievement scores.

	B	Standard Error	Beta	t	p
Fixed	-.634	8.327		-.076	.939
Maths Motivation	12.090	2.115	.269	5.715	.000

Dependent Variable: Achievement Score in Solving Mathematics Problems

As seen in Table 13, as a result of simple linear regression analysis, it was found that mathematics motivation had a low level positive significant relationship with mathematics problem-solving achievement score ($r=.26$; $r^2=.07$; $p\leq.05$). While this relationship is statistically significant, its practical effect size is limited. The increase in the maths problem-solving achievement score was explained by a factor that accounted for 7% of the variation in the data.

DISCUSSION, CONCLUSION, and RECOMMENDATIONS

This study aimed to examine the relationship between mathematics motivation and mathematics problem-solving skills among fourth-grade primary school students. In this context, the Mathematics Course Motivation Scale developed by Tahiroğlu and Çakır (2014) was applied and the Mathematics Problem-solving Achievement Test developed by the researcher was used. The findings are discussed below.

Results related to mathematics motivation levels

The findings of this study showed that the mathematics motivation of fourth-grade primary school students was at a high level. Students with high motivation are expected to show interest in the lesson and make an effort to be successful. Similarly, in studies conducted by Senemoğlu (2007), Bozkurt and Bircan (2015), Kılıç (2022) and Süren (2019), it was stated that high motivation level has a positive effect on student achievement. However, another study conducted by Külünk Akyurt (2019), concluded

that students' mathematics motivation was at a medium level. Despite this variety of variables, it can be considered a positive situation that students' mathematics motivation was high in the study.

Results related to maths problem solving levels

According to the findings of this study, it was determined that the mathematics problem-solving scores of fourth-grade primary school students were at the level of "Should be improved". Accordingly, it can be said that students' achievement scores in solving mathematical problems are low. In support of this study, Artut and Tarım (2006) also concluded that the achievement level of secondary school students in non-routine problems was low. However, Al Shabibi and Alkharusi (2018) concluded that students' problem-solving skills were high. Low problem-solving skills can be explained by factors such as students not having sufficient problem-solving experience or not using problem solving strategies sufficiently.

It is a noteworthy finding that while students exhibit a high level of motivation in mathematics, their success in problem-solving is limited. This finding is consistent with the PISA 2018 and 2022 results, which revealed that even students with high mathematics achievement demonstrated lower than expected performance in problem-solving and application skills (OECD, 2012; 2015). Devetter and Çalışkan's (2015) findings also indicate that students who exhibit high levels of mathematics motivation may nevertheless demonstrate deficiencies in their conceptual understanding and problem-solving strategies. Abin et al. (2020) also found that motivational and affective variables did not play a significant role in mathematics achievement. The extant literature suggests that high motivation is important for successful outcomes, but additional factors such as conceptual depth and strategy development are more decisive in problem-solving skills. It can be concluded that mathematics motivation alone is insufficient for problem-solving success.

Results of mathematics motivation and mathematics problem-solving skills on students' change of teacher

The results of this study showed that mathematics motivation and mathematics problem-solving achievement scores of fourth-grade primary school students did not differ significantly according to their teacher change status. This finding reveals that the mathematics motivation and mathematics problem-solving skills of the students who changed teachers for different reasons in primary school were not affected by this situation. It is possible that this phenomenon may be attributable to the presence of other variables that exert an influence on mathematics motivation and mathematics problem-solving skills. Such variables may include high teacher morale and the establishment of a positive school culture and classroom climate.

Results related to the investigation of mathematics motivation according to students' mother and father education levels

The results of this study revealed that the mathematics motivation of fourth-grade primary school students did not differ significantly according to their mother's education level. This finding shows that the level of maternal education is not a determining factor in the mathematics motivation of primary school 4th grade students. The studies of Demir and Arıcı (2013), Kara and Özkaya (2022) and Külünk Akyurt (2019) also support this result. However, there are also studies in the literature that reach different results. In his study, Akdemir (2006) determined that the achievement motivation scores of students whose mothers graduated from primary school were higher than the scores of students whose mothers graduated from 4-year faculties. Özdemir (2021) found that the mathematics motivation of students whose mothers graduated from secondary school was lower than that of students whose mothers were illiterate and graduated from primary school. Karaman and Mutluer (2023) found that the mathematics identified extrinsic motivation levels of students whose mothers were illiterate, primary school graduates or only literate were significantly higher than those of students whose mothers were secondary school graduates.

On the other hand, it was found that students' mathematics motivation differed significantly according to their father's education level. It was determined that students whose fathers graduated from primary

school had higher mathematics motivation than students whose fathers graduated from secondary school and students whose fathers graduated from university and above had higher mathematics motivation than students whose fathers graduated from secondary school. This result shows that fathers with both low education level (primary school) and high education level (university and above) are more effective in supporting their children's mathematics motivation. The possible reasons for this result may be that fathers who graduated from primary school want their children to receive more education than themselves and therefore support them more, while fathers who graduated from university are aware of the importance of the education they receive and motivate their children with this awareness. Similarly, in the study conducted by Yerlikaya (2014), it was found that mathematics motivation differed significantly according to the level of father education. However, there are also studies in the literature showing that father's education level has no significant effect on student motivation (Akdemir, 2006; Demir & Arı, 2013; Kara & Özkaya, 2022; Karaman & Mutluer, 2023; Külünk Akyurt, 2019; Özdemir, 2021). These different results may be due to the socio-cultural characteristics of the regions where the studies were conducted, the differences in the research groups or the diversity of the measurement tools used.

Results related to the investigation of mathematics problem-solving skills according to students' mother and father education levels

According to the research findings, it was concluded that the mathematics problem-solving achievement scores of fourth-grade primary school students differed significantly according to the level of mother's education. This significant difference was in favour of mothers who graduated from primary school and mothers who graduated from high school in favour of mothers who graduated from primary school, and in favour of mothers who graduated from university and above in favour of mothers who graduated from university and above in favour of mothers who graduated from secondary school and high school. This shows that the mathematics problem-solving achievement scores of the students whose mothers have primary school or university, and above graduation are significantly higher than the others. The findings of the study support the findings of Dursun and Dede (2004), Külünk Akyurt (2019) and Yenilmez and Duman (2008). It is hypothesised that the mathematical problem-solving achievements of students whose mothers have attained a university education are likely to be elevated. However, the finding that the mathematics problem-solving achievements of students whose mothers graduated from primary school are significantly higher than those whose mothers graduated from high school is unexpected. This phenomenon can be attributed to a variety of factors, including psychosocial elements such as the endeavours of mothers who have completed primary education to redress the limitations imposed by their own educational attainment through the accomplishments of their offspring.

According to the research findings, it was concluded that the mathematics problem-solving achievement scores of fourth-grade primary school students differed significantly according to their father's education level. Accordingly, it was determined that students whose fathers were university and above graduates were significantly more successful in solving mathematical problems than students whose fathers were high school graduates. This may be due to the fact that fathers with university and higher education are more likely to be able to guide students more accurately in solving mathematical problems. The findings of the study overlap with the findings of Külünk Akyurt (2019) and Yenilmez and Duman (2008).

Results on the relationship between students' mathematics motivation and mathematics problem-solving skills

When the relationship between mathematics motivation and mathematics problem-solving skills was examined, a positive, significance but weak was found. This finding shows that mathematics motivation cannot fully explain students' ability to solve mathematical problems, the level of effect is low but it can be effective at a certain level. Kesici (2018) also reported a significant relationship between mathematics motivation and achievement.

Results related to the question of whether students' mathematics motivation is a significant predictor of mathematics problem-solving skills

Finally, according to the results of the regression analysis, mathematics motivation was a significant predictor of mathematics problem-solving achievement. However, considering that motivation explained only 7% of the variance in problem-solving achievement, other variables affecting problem-solving achievement should be examined.

Recommendations

Recommendations for researchers

In this study, mathematics problem solving skill levels should be improved, i.e. they were low. In further studies, the reasons for the low scores observed in students' mathematics problem-solving skills can be investigated.

This study found that mathematics problem-solving achievement scores differed significantly according to father and mother education variables. To better understand these effects, qualitative studies involving both mothers and fathers as participants are recommended.

This study found a weak but positive relationship between mathematics motivation and problem-solving skills. Further research could examine this relationship across different student samples.

Recommendations for teachers

In this study, it was concluded that students' success in solving mathematical problems was at the level of 'should be improved.' Accordingly, teachers can be recommended to use different strategies, methods and techniques that can improve these skills of students.

As a result of this research, a weak positive relationship was found between students' mathematics motivation and their mathematics problem-solving achievement. Accordingly, it can be suggested to teachers that discourses and practices that will increase students' mathematics motivation will not be sufficient to increase their mathematics problem-solving success, and that they should consider other variables that will increase their mathematics problem-solving success.

Ethics and Conflict of Interest

The permission was obtained from the Ethics Committee of Kahramanmaraş Sütçü İmam University with the letter dated 11.11.2022 and numbered 172202. The authors declare that they have no conflict of interest. This article was produced from the master's thesis conducted by the first author under the supervision of the second author.

Author Contribution

All authors contributed equally to the research.

Data availability

The data that support the findings of this study are available on request from the corresponding author.

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