International Journal of Social Inquiry *16*(1), 2023, pp.95−110
journal homepage: https://dergipark.org.tr/en/pub/ijsi

International Journal of Social Inquiry
International Peer-Reviewed Open Access Electronic Journal
E-ISSN: 1307-9999
Volume 16 Issue 1 June 2023

RESEARCH ARTICLE
https://doi.org/10.37093/ijsi.1258062

The Correlation Between Middle School 8th-Grade Students' Reflective Thinking Skill Towards Problem-solving and Their Mathematics Anxieties

Süruri Selim Erdem[*] Elif Esra Arıkan[**]

Abstract

This research aims to explore the potential correlation between the reflective thinking skills of 8th-grade students in secondary education and their level of math anxiety. The study also intends to investigate potential discrepancies in students' reflective thinking abilities for problem-solving and mathematics anxiety, considering factors such as gender, parental education level, and the type of games played. One of the quantitative research designs, the relational survey model, was employed in this study. There were 779 8th-grade students in the study group, comprising 415 females and 364 males. The researchers collected data using three tools: the reflective thinking skills in problem-solving scale developed by Kızılkaya and Aşkar (2009), the mathematics anxiety scale developed by Bindak (2005), and a personal information form created by the researchers. The data obtained from the scales were analyzed using statistical methods such as arithmetic mean, t-test, analysis of variance (ANOVA), and Scheffe test. A noteworthy finding is that the math anxiety scale score and the reflective thinking skills scale score for problem-solving exhibit a significant difference based on the type of game played by the students. An important finding is that the reflective thinking skill scale for problem-solving reasoning sub-dimension accounts for 10% of the total variance in mathematics anxiety, as revealed by the multiple regression analysis.

Keywords: Middle school 8th-grade students, reflective thinking towards problem-solving, mathematics anxiety.

Cite this article: Erdem, S. S., & Arıkan, E. E. (2023). The Correlation between middle school 8th-grade students' reflective thinking skill towards problem-solving and their mathematics anxieties. *International Journal of Social Inquiry*, *16*(1), 95−110. https://doi.org/10.37093/ijsi.1258062

[*] Specialist, Istanbul Provincial Directorate of National Education, Strategy Development Unit, İstanbul, Türkiye.
E-mail: s.selimerdem58@gmail.com, ORCID: https://orcid.org/0000-0002-3781-6092

[**] Assoc. Prof. Dr., İstanbul Sabahattin Zaim University, Faculty of Education, Department of Mathematics and Science Education, Elementary Mathematics Teaching Program, İstanbul, Türkiye (Corresponding author).
E-mail: elif.arikan@izu.edu.tr, ORCID: https://orcid.org/0000-0003-2775-0373

Article Information

Received 28 February 2023; Revised 27 May 2023; Accepted 09 June 2023; Available online 30 June 2023

1. Introduction

Problem-solving skills are considered one of the most critical required features of 21st-century individuals (Kailani et al., 2019; Oluk & Çakır, 2019). Many researchers have claimed that problem-solving should be taught during mathematics classes to enrich mathematical knowledge, structure new information, and increase the quality of our life standards (Charles & Lester, 1982; Dede & Yaman, 2005; Silver & Marshall, 1990; Toluk & Olkun, 2002). In Türkiye, the Ministry of Education [MEB] has updated and improved teaching programs following the developments in the world. The development of math curriculums in 2009, 2013, and 2018 emphasized enhancing problem-solving skills. The latest update in 2018 also stated the special objective of sustaining mathematical reasoning through problem-solving skills. (MEB, 2018). In studies related to mathematics, analyses that are based on performances are conducted on problems (Wilson et al., 1993). The reasoning, strategic planning, control, and decision-making processes of students during problem-solving are examined and then the probable misconceptions or errors are corrected. Therefore, the role of problem-solving in mathematics classes is particularly significant. Another proponent of problem-solving's importance in education is Piggott (2011), who sees it as a means of addressing the issue of creativity in the classroom. Schoenfeld (1992, as cited in Günen, 2019) highlighted that problem-solving is one of the bases of mathematical thinking. Using reflective thinking skills when solving problems enables students to act consciously because activities based on logic, checking results, and knowing why something has been done occur with reflective thinking skills. Dewey (1933, as cited in Kızılkaya & Aşkar, 2009) is the first researcher who puts forward the concept of reflective thinking. The decision process of the interrelated ideas based on knowledge according to a cause-and-effect pattern represents reflective thinking. Dewey ranks reflective meetings into five stages, namely suggestions, problems, hypotheses, reasoning, and testing. The reason is that problems may not have a single correct answer, and the students may need to choose the most appropriate one among many suitable options. Therefore, asking questions one at a time for each answer is necessary. The Turkish education system relies on nationwide central examinations to determine the transition from middle school to high school, high school to university, and ultimately from university to public workplaces. A significant proportion of the questions are related to mathematics. The nationwide exams start with the High School Entrance Exam, followed by the Basic Proficiency Test and Field Qualification Tests (TYT-AYT), which are used to select university students. The process concludes with the Selection Test for Civil Servants (KPSS) and Academic Personnel Selection Exam (ALES). Since mathematics is the central focus of these examinations, it is ensured that this matter receives the necessary attention. Mathematics classes are known to complement other issues, but students often experience stress and pressure during these classes. Over time, stress and tension can develop into anxiety.

Anxiety is a state of stimulation that displays itself together with physical, mental, and emotional changes when people experience an incident. In the event of anxiety, people feel like something will happen to them and go into an alarm state. The most important difference between fear and anxiety is the emotion's source, length, and intensity. Fear occurs more intensely than anxiety, but the size of fear is shorter than anxiety. Although the origin of fears is definite, the source of anxieties is generally indefinite (Uysal, 2007).

Although math anxiety generally appears during math classes, it confronts people in every part of their lives. We can face math anxiety when dealing with mathematical calculations in our everyday lives, and we can also encounter it when solving mathematics problems or dealing with mathematics. Mathematics anxiety refers to the negative feelings of stress and worries experienced by students when dealing with concepts such as numbers, symbols, and problem-solving processes (Rossnan, 2006).

Furner and Duffy (2002) claim that the causes of mathematics anxiety are affected by educational systems, socio-economic conditions, gender, and family background. Having negative experiences is among the most important reasons for mathematics anxiety. The attitudes of teachers, limiting problem-solving with time, a humiliation in front of peers, not using teaching materials, and making a wrong choice deciding the teaching technique result in mathematics anxiety in students.

One of the most important reasons for mathematics anxiety is not having developed problem-solving abilities. Problem-solving cannot be considered apart from the nature of mathematics.

2. Method

2.1 The Purpose of the Study

This study aims to investigate the existence of a meaningful relationship between 8th-grade students' reflecting thinking skill scale towards problem-solving and their mathematical anxieties. In this regard, the answers to the following questions are searched:

1. Is there a difference in the reflective thinking skill scale towards problem-solving scores of 8th-grade students in middle school based on their gender, their mother's education level, their father's education level, and the type of game they prefer playing?
2. Is there a difference in math anxiety scores among 8th-grade middle school students based on gender, mother's education level, father's education level, and preferred type of game?
3. Is there a significant relationship between the mathematics anxieties of middle school students and their reflective thinking skill towards problem-solving?

2.2 The Model of the Study

In this study, correlational scanning model, one of the quantitative research methods, was used. The correlational screening model is "a research methodology utilized to examine the existing relationships between two or more variables" (Büyüköztürk et al., 2020, p. 16).

2.2.1 Participants

Table 1 displays the demographic characteristics. The research involved a sample of 8th-grade students from Türkiye, consisting of 47% male and 53% female participants. After examining the educational background of the mothers of the participants, it was found that 48% had completed primary education, 20% had achieved secondary education, 21% had finished high school, and 11% had earned a university degree. On the other hand, the educational attainment of the fathers was distributed as follows: 32% had completed primary education, 21% had

completed secondary education, 32% had completed high school, and 16% had obtained a university degree. The current study demonstrates that a significant number of students participate in different types of games. One-fourth of the students have a preference for brain games, whereas adventure games are played by 28% of the participants. Furthermore, it can be observed that 10% of the students exhibit a preference for racing games, while 30% of the students engage in playing war games. Other types of games are engaged in by the remaining 7% of the students.

Table 1

The Descriptive Features of the Participants

Baseline characteristic		*n*	*%*
Gender	Female	415	53.3
	Male	364	46.7
Mothers' degree	Primary school	372	47.8
	Middle school	159	20.4
	High School	162	20.8
	University	86	11.0
Fathers' degree	Primary or lower	239	30.7
	Middle school	163	20.9
	High School or higher	251	32.2
	University	126	16.2
Game type	Brain Games	195	25.0
	Adventure Games	218	28.0
	Racing Games	80	10.3
	War Games	230	29.5
	Others	56	7.2

Note. N=779

2.2.2 Data Collection Instruments

The authors collected data using three instruments: *the reflective thinking skills for problem-solving scale* developed by Kızılkaya and Aşkar (2009), *the mathematics anxiety scale* developed by Bindak (2005), and a *personal information form* created by the researchers. The personal information form consists of four questions that pertain to gender, the education levels of the participant's mother and father, and their preferred type of games.

A scale about reflective thinking skill scale towards problem-solving was developed by Kızılkaya and Aşkar (2009) to measure the usage of reflective thinking skills in the problem-solving process. The scale comprises of three sub-factors, namely reasoning, questioning, and evaluation. There are 14 items included in the scale. Items 1, 3, 7, 9, and 13 pertain to *questioning*, while items 2, 4, 6, 10, and 14 relate to *evaluation*. The remaining items, 5, 8, 11, and 12, are associated with *reasoning* sub-factor. Action frequencies in the scale were arranged as always, generally, sometimes, rarely and never. The scoring system for the given criteria is as follows: "Always" is assigned 5 points, "generally" is given 4 points, "sometimes" is worth 3 points, "rarely" is valued at 2 points, and "never" is assigned 1 point. To determine the level of reflective thinking skills for problem-solving, one can calculate the total points assigned to each answer on the scale. The Cronbach's alpha coefficient for the 14-item scale was calculated to be 0.799 with a 95% confidence level. In their study, Kızılkaya and Aşkar (2009) reported a Cronbach alpha coefficient of 0.83 for all the items on the scale.

The Mathematics Anxiety Scale was developed by Bindak (2005) to to assess the level of mathematics anxiety experienced by students during the process of learning mathematics. The scale comprises ten items, with the ninth item being graded reversely. The frequencies of actions on the scale were organized in the following order: always, generally, sometimes, rarely, and never. The answer "always" was worth 5 points, "generally" 4, "sometimes" 3, "rarely" 2, and "never" 1. The ninth element of the scale was subjected to reverse grading. The level of mathematical anxiety can be calculated by summing up the points given for each answer. Students' anxieties about mathematics were measured using a 10-item scale, and Cronbach's alpha was calculated to be 0.901 at a 95% confidence level. The coefficient was 0.83 in Bindak's (2005) study.

2.2.3 Data Analysis

The statistical analysis of the data in this study was conducted utilizing the SPSS 25 software. Upon analysis of the reflective skills' total score for the problem-solving scale and the normality test of scores obtained from the scale's sub-factors, it was observed that the skewness and kurtosis values fell within the −1.5 and +1.5 intervals. Hence, it was comprehended that they exhibited a normal distribution. The mean score of 779 participations on the reflective thinking skills for problem-solving scale is 51.48. Upon analyzing the scale's total score, it was observed that the reflective thinking skills for problem-solving range from 14 to 70, with the latter being the highest and the former being the lowest. Table 2 presents the mean values, standard deviation, minimum and maximum scores, as well as the skewness and kurtosis coefficients for the reflective thinking skills for the problem-solving scale.

Table 2

Descriptive Statistics for the Reflective Skills for Problem-solving Scale

Baseline characteristic	*SEM*	*SD*	*Var.*	*Max.*	*Min.*	*M*	*Skewness*	*Kurtosis*
Gender								
Female	.42	8.74	76.50	70	14	53.11	–0.63	0.92
Male	.50	9.62	92.70	70	16	49.62	–0.43	0.11
Mothers' Degree								
Primary school	.48	9.30	86.66	70	14	51.79	–0.51	0.50
Middle school	.76	9.70	94.26	70	22	50.81	–0.43	–0.18
High School	.68	8.77	76.97	67	16	51.95	–0.76	1.16
University	1.04	9.70	94.15	70	20	50.45	–0.57	0.57
Fathers' Degree								
Primary school	.63	9.74	95.04	70	14	51.48	–0.54	0.60
Middle school	.77	9.88	97.62	70	24	50.91	–0.58	–0.19
High School	.58	9.27	86.10	70	16	51.57	–0.54	0.51
University	.69	7.81	61.00	70	26	52.03	–0.37	0.73
Game Type								
Brain Games	.64	9.01	81.24	70	20	54.41	–0.77	0.82
Adventure Games	.56	8.31	69.17	70	32	52.59	–0.32	–0.32
Racing Games	1.02	9.19	84.54	70	26	50.78	–0.09	–0.13
War Games	.63	9.65	93.29	70	14	48.33	–0.55	0.67
Other	1.21	9.12	83.32	65	22	50.85	–1.05	1.16

Note. SEM=Standard error of the mean.

The arithmetic mean of the mathematics anxiety scale scores for 779 participants is 23.66. Our research indicates that the mathematics anxiety scale has a maximum score of 50 and a minimum score of 10. Table 3 displays the means, standard deviations, minimums, maximums, skewness, and kurtosis coefficients for the mathematics anxiety scale.

Table 3

Descriptive Statistics for the Mathematics Anxiety Scale

Baseline characteristic	*SEM*	*SD*	*Var.*	*Max.*	*Min.*	*M*	Skewness	Kurtosis
Gender								
Female	.53	10.95	119.98	50	10	24.39	.55	–.76
Male	.51	9.90	98.10	50	10	22.84	–.53	–.64
Mother's Degree								
Primary school	.54	10.42	108.77	50	10	24.18	.48	–.75
Middle school	.84	10.68	114.25	49	10	24.26	.42	–.95
High School	.81	10.34	106.93	50	10	22.54	.79	–.22
University	1.14	10.65	113.4750	50	10	22.46	.78	–.12
Father's Degree								
Primary school	.73	11.29	127.50	50	10	25.99	.38	–.93
Middle school	.81	10.40	108.21	50	10	24.84	.38	–.90
High School	.59	9.49	90.12	46	10	21.86	.56	–.79
University	.88	9.92	98.48	50	10	21.30	1.00	.47
Game Type								
Brain Games	.71	9.93	98.78	50	10	20.87	.99	.07
Adventure Games	.72	10.70	114.56	50	10	24.67	.43	–.82
Racing Games	1.10	9.85	97.21	48	10	23.72	.37	-.93
War Games	.71	10.82	117.22	50	10	25.32	.42	–.84
Other	1.24	9.31	88.68	50	10	22.57	.55	.16

Note. SEM=Standard error of the mean.

3. Findings

3.1 Differences in Reflective Thinking Skills for Problem-Solving According to Gender, Mother and Father Education Level, and Game Preferences

Table 4 presents the results of an independent group t-test that compared the average scores of the reflective thinking skill scale towards problem-solving and its sub-dimensions based on gender.

Upon examining Table 4, a significant difference is apparent in the scores of the reflective thinking skill scale towards problem-solving ($t_{p\text{-total}(777)}$=5.29, ρ <.00) and its subscales, with respect to the gender variable, in favor of female students ($t_{p\text{-questioning}(777)}$=4.02, ρ <.00; $t_{p\text{-reasoning}(777)}$=3.58. ρ <.00; $t_{p\text{-evaluation}(777)}$=6.11, ρ <.00). The impact of the gender variable on reflective thinking skills for problem-solving and its subscales (dp-questioning=.29, dp-reasoning=.43, dp-evaluation=.37 and dp-total=.28) is relatively weak.

Table 4

The Results of Reflective Thinking Skills for Problem-solving Scale According to Gender Variable

Scale	Gender	*n*	*M*	*SD*	*t*	*df*	*p*	Cohen's *d*
p-questioning	Female	415	15.60	2.98	4.02	777	.00	0.29
	Male	364	14.79	3.27				
p-reasoning	Female	415	19.09	3.45	3.58	777	.00	0.43
	Male	364	17.50	3.79				
p-evaluation	Female	415	53.11	8.75	6.11	777	.00	0.37
	Male	364	49.62	9.63				
P-total	Female	415	18.41	3.60	5.29	777	.00	0.28
	Male	364	17.32	3.94				

Table 5 presents the outcomes of a one-way ANOVA analysis that compares the scales determining reflective thinking skills toward problem-solving with respect to the mother's educational level. The analysis of variance indicated that there was no significant variation in the reflective thinking skills of students about their mothers' educational status in problem-solving.

Table 5

The Results of Reflective Thinking Skills Towards Problem-solving Scale According to Mother's Education Level Variable

Scale	Mother's education level	*n*	*M*	Variance Source	SS	*df*	*MS*	*F*	*p*
p-questioning	Primary school	372	17.95	Between Groups	65.97	3	21.992	1.52	0.206
	Middle school	159	17.72	Within Groups	11162.55	775	14.403		
	High School	162	18.30	Total	11228.52	778			
	University	86	17.27						
p-reasoning	Primary school	372	15.25	Between Groups	53.01	3	17.673	1.79	0.147
	Middle school	159	14.76	Within Groups	7638.66	775	9.856		
	High School	162	15.55	Total	7691.68	778			
	University	86	15.31						
p-evaluation	Primary school	372	18.58	Between Groups	51.68	3	17.227	1.26	0.285
	Middle school	159	18.32	Within Groups	10559.34	775	13.625		
	High School	162	18.09	Total	10611.02	778			
	University	86	17.86						
p-total	Primary school	372	51.79	Between Groups	234.91	3	78.305	0.9	0.441
	Middle school	159	50.81	Within Groups	67443.60	775	87.024		
	High School	162	51.95	Total	67678.51	778			
	University	86	50.45						

Note. SS=Sum of square; MS=Mean square

Table 6 presents a comparison of students' reflective thinking skills in problem-solving with respect to the variable of the father's educational level. Likewise, no statistically significant difference exists in the reflective thinking skills of students concerning problem-solving based on the educational levels of their fathers.

Table 6

The Results of Reflective Thinking Skills Towards Problem-solving Scale According to Father's Education Level Variable

Scale	Father's education level	*n*	*M*	Variance Source	*SS*	*df*	*MS*	*F*	*p*
p-questioning	Primary school	239	17.90	Between Groups	26.69	3	8.899	0.616	0.605
	Middle school	163	17.58	Within Groups	11201.83	775	14.454		
	High School	251	18.00	Total	11228.53	778			
	University	126	18.14						
P-reasoning	Primary school	239	15.11	Between Groups	65.92	3	21.975	2.233	0.083
	Middle school	163	14.89	Within Groups	7625.76	775	9.840		
	High School	251	15.23	Total	7691.68	778			
	University	126	15.82						
p-evaluation	Primary school	239	18.46	Between Groups	14.80	3	4.934	0.361	0.781
	Middle school	163	18.43	Within Groups	10596.23	775	13.673		
	High School	251	18.32	Total	10611.03	778			
	University	126	18.06						
p-total	Primary school	239	51.48	Between Groups	92.76	3	30.920	0.355	0.786
	Middle school	163	50.91	Within Groups	67585.76	775	87.207		
	High School	251	51.57	Total	67678.52	778			
	University	126	52.03						

Note. SS=Sum of square; MS=Mean square

Subsequently, an ANOVA test was conducted to investigate the potential impact of students' preferred games on their reflective thinking skill scale towards problem-solving (see Table 7).

Table 7

The Results of Reflective Thinking Skills Towards Problem-solving Scale According to Type of Preferred Game Variable

Scale	Type of Preferred Game	n	M	Variance Source	*SS*	*df*	*MS*	*F*	*p*	Scheffe	Cohen's *d*
P-questioning	A. Brain Games	195	18.92	Between Groups	655.30	3	163.82	11.993	.000	A>D	0.56
	B. Adventure Games	218	18.50	Within Groups	10573.22	775	13.66			A>E	0.56
	C. Racing Games	80	17.91	Total	11228.52	778				B>D	0.47
	D. War Games	230	16.78							B>E	0.48
	E. Other	56	16.67								
P-reasoning	A. Brain Games	195	15.90	Between Groups	308.26	3	77.06	8.079	.000	A>D	0.50
	B. Adventure Games	218	15.59	Within Groups	7383.41	775	9.53			B>D	0.42
	C. Racing Games	80	15.10	Total	7691.68	778					
	D. War Games	230	14.32								
	E. Other	56	15.32								
P-evaluation	A. Brain Games	195	19.58	Between Groups	629.04	3	157.26	12.19	.000	A>C	0.50
	B. Adventure Games	218	18.50	Within Groups	9981.98	775	12.89			A>D	0.65
	C. Racing Games	80	17.77	Total	10611.02	778				B>D	0.34
	D. War Games	230	17.23								
	E. Other	56	18.85								
P-total	A. Brain Games	195	54.41	Between Groups	4278.70	3	1069.67	13.059	.000	A>D	0.65
	B. Adventure Games	218	52.59	Within Groups	63399.81	775	81.91			B>D	0.47
	C. Racing Games	80	50.78	Total	67678.51	778					
	D. War Games	230	48.33								
	E. Other	56	50.85								

Note. SS=Sum of square; MS=Mean square

There is a significant difference between the reflective thinking skill towards problem-solving according to the game variable that students prefer playing, both in the scale itself ($F_{(4-774)}$= 13.059; ρ<.05) and in its sub-dimensions (Fp-questioning$_{(4-774)}$= 11.993; ρ<.05; Freasoning$_{(4-774)}$= 8.079; ρ <.05; Fevaluation$_{(4-774)}$= 12.19; ρ <.05).

Therefore, the Scheffe test was employed to investigate the groups that exhibited a statistically significant difference. Consistent with the findings in Table 7, students who played the brain game scored significantly higher on both the overall scale and the sub-dimensions of reflective thinking skills for problem-solving than their counterparts who played the war game. The calculated Cohen's *d* coefficient for evaluating the size of group differences is also shown in Table 7.

There are statistically significant differences in the reflective thinking skills towards problem-solving scores in the *questioning* dimension between students who prefer *brain games* and *war games* ($\bar{X}_{braingames} - \bar{X}_{wargames} = 2.14, \rho = .00$), as well as between those who prefer *brain games* and *other games* ($\bar{X}_{braingames} - \bar{X}_{other} = 2.24, \rho = .00$). A similar difference was observed in favor of students who played *adventure games* ($\bar{X}_{adventuregames} - \bar{X}_{wargames} = 1.71, \rho = .00$; $\bar{X}_{adventuregames} - \bar{X}_{other} = 1.82, \rho = .03$). Based on the effect size coefficients, there is a moderate difference in the reflective thinking skill scores for problem-solving between students who engage in *brain games* and those who engage in *war* and *other games* ($d_{A>D}$=0.56, $d_{A>E}$=0.56). Moreover, a slight difference exists in the reflective thinking skills for problem-solving between students who play *adventure games* and those who play *war* and *other games* ($d_{B>D}$=0.47, $d_{B>E}$=0.48).

The arithmetic averages of scores obtained from the reflective thinking skills scale towards problem-solving exhibit a notable discrepancy in the *reasoning* sub-dimension between students who prefer playing *brain games* and those who play *war games* ($\bar{X}_{braingames} - \bar{X}_{wargames} = 1.58, \rho = .00$). Additionally, students who play *adventure games* also demonstrate a similar advantage ($\bar{X}_{adventuregames} - \bar{X}_{wargames} = 1.27, \rho = .00$). Based on the effect size coefficients, it can be inferred that there is a moderate difference in the reflective thinking skill scores for problem-solving between students who play *brain games* and those who play *war games* ($d_{A>D}$=0.50). On the other hand, there is a weak difference in the reflective thinking skills for problem-solving between students who play *adventure games* and those who play *war games* ($d_{B>D}$=.042).

The *evaluation* sub-dimension reveals a statistically significant disparity in the mean scores of reflective thinking skills scale towards problem-solving among students who favor playing *brain games* in contrast to those who engage in *race games* ($\bar{X}_{braingames} - \bar{X}_{racegames} = 1.8, \rho = .001$) and war games ($\bar{X}_{braingames} - \bar{X}_{wargames} = 2.34, \rho = .00$). Similar to the other sub-dimensions, there exists a substantial disparity between the mean scores of reflective thinking skills for problem-solving among students who engage in *adventure games* and those who participate in *war games* ($\bar{X}_{adventuregames} - \bar{X}_{wargames} = 1.26. \rho = .001$). Based on the effect size coefficients, there is a moderate difference in the reflective thinking skill scores for problem-solving between students who engage in *brain games* and those who participate in racing and *war games* ($d_{A>C}$=0.50, $d_{A>D}$=0,65). Furthermore, there exists a weak difference in reflective thinking skills for problem-solving between students who engage in *adventure games* and those who participate in *war games* ($d_{B>D}$=0.34).

Finally, there is a significant difference between students who play *war games* and those who play *brain games* ($\bar{X}_{braingames} - \bar{X}_{wargames} = 6.07, \rho = .00$) and students who play *war games* and those who play *adventure games* ($\bar{X}_{adventuregames} - \bar{X}_{wargames} = 4.25, \rho = .00$) on the reflective thinking skills for problem-solving scale. The effect size coefficients indicate that there is a moderate difference in reflective thinking skills for problem-solving between students who play *brain games* and those who play *war games* ($d_{A>D}$ =0.65). On the other hand, there is a weak difference in reflective thinking skills for problem-solving between students who play *adventure games* and those who play *war games* ($d_{B>D}$=0.47).

3.2 Differences in Mathematics Anxiety According to Gender, Mother and Father Education Level, and Game Preferences

In order to measure the mathematics anxiety of 779 students participating in the study, the mathematics anxiety scale developed by Bindak (2005) was utilized. The arithmetic mean of the scores obtained from the scale was calculated to be 23.66. In this section, we compared the arithmetic averages of the scores obtained from the scale based on different variables such as gender, mother's education level, father's education level, and the types of games played by the students. Table 8 compares the arithmetic averages of the students' scores from the mathematics anxiety scale based on gender.

The study found that female students exhibited higher levels of anxiety compared to their male counterparts. This conclusion was drawn from the results of an independent sample t-test, which was conducted to investigate the impact of gender on mathematics anxiety levels. The statistical analysis revealed a significant difference between the two groups ($t_{[777]}$ =2.077; $\bar{x}$ = 24.39; ρ = .038<.05). The impact of the gender variable on math anxiety is found to be weak (d=.20).

Table 8

The Results of Mathematics Anxiety Scale According to Gender Variable

Scale	*Gender*	*N*	*M*	*SD*	*t*	*df*	*p*	Cohen's *d*
Total anxiety	Female	415	24.39	10.95	2.077	777	.038	0.20
	Male	364	22.84	9.90				

Table 9 presents the results of a one-way ANOVA test that investigated the potential impact of the educational attainment of students' mothers on their level of mathematics anxiety. There appears to be a decreasing tendency in students' mathematical anxiety in line with mothers' educational attainment, according to the mean scores on the scale. However, this trend is not statistically significant as the *p*-value (0.223) is greater than the standard alpha level of .05.

Table 9

The Results of Mathematics Anxiety Scale According to Mother's Education Level Variable

Scale	Mother's education level	*n*	*M*	Variance Source	*SS*	*df*	*MS*	*F*	*p*
Total anxiety	Primary school	372	24.18	Between Groups	483.45	3	161.15	1.46	0.223
	Middle school	159	24.26	Within Groups	85271.43	775	110.02		
	High School	162	22.54	Total	85754.88	778			
	University	86	22.46						

Note. SS=Sum of square; MS=Mean square

Table 10 presents the results of a one-way ANOVA test that investigated the potential impact of the educational attainment of students' fathers on their level of mathematics anxiety. Students' mathematics anxiety decreases when their father's educational attainment increases, as does their mother's; however this change is statistically significant ($F_{(3-775)}$ =9.479; ρ=.000<.05).

Specifically, students whose fathers have completed primary school education exhibit significantly higher levels of mathematics anxiety compared to those whose fathers have completed high school education (ρ=.00<.05) and university education (ρ =.001<.05). The results indicate a statistically significant difference in mathematics anxiety scores between students whose fathers have secondary school education and those whose fathers have high school education (ρ =.043<.05) or university education (ρ =.040<.05). Father's education level variable has a weak effect size for mathematics anxiety ($d_{A>C}$=.39, $d_{A>D}$=.44, $d_{B>C}$=.29 and $d_{B>D}$=.34).

Table 10

The Results of Mathematics Anxiety Scale According to Father's Education Level Variable

Scale	Father's education level	*n*	*M*	Variance Source	*SS*	*df*	*MS*	*F*	*p*	Scheffe	Cohens's *d*
Mathematics anxiety	A. Primary school	239	25.99	Between Groups	3035.13	3	1011.71	9.479	0.00	A>C	0.39
	B. Middle school	163	24.84	Within Groups	82719.75	775	106.73			A>D	0.44
	C. High School	251	21.86	Total	85754.88	778				B>C	0.29
	D. University	126	21.30							B>D	0.34

Note. SS=Sum of square; MS=Mean square

In Table 11, students who play brain games report lower levels of math anxiety than those who play adventure and war games. The magnitude of the effect of game type on mathematics anxiety is weak ($d_{A>B}$ =.36, $d_{A>D}$.43).

Table 11

The Results of Mathematics Anxiety Scale According to Game Type Variable

Scale	Type of Preferred Game	*n*	*M*	Variance Source	*SS*	*df*	*MS*	*F*	*p*	Scheffe	Cohens's *d*
Mathematics anxiety	A. Brain Games	195	20.8769	Between Groups	2438.46	4	609.616	5.663	.000	A>B	0.36
	B. Adventure Games	218	24.6789	Within Groups	83316.42	774	13.66			A>D	0.43
	C. Racing Games	80	23.7250	Total	85754.88	778					
	D. War Games	230	25.3217								
	E. Other	56	22.5714								

Note. SS=Sum of square; MS=Mean square

3.3 The Relationship Between Students' Reflective Thinking Skill Towards Problem-Solving and Their Mathematics Anxiety

The study analyzed students' total scores on reflective thinking skills for problem-solving and mathematics anxiety, with independent variables such as gender, mother, and father education status, and game types. The analysis determined whether the scores differed based on these variables using independent sample t-tests and one-way ANOVA tests. The results are presented in the tables above.

In the third sub-problem of the study, the relationship between students' reflective thinking skill towards problem-solving and their mathematics anxiety was examined. The findings are detailed in Table 12.

Table 12

The Relationship Between Mathematics Anxiety Scale and Reflective Thinking Skill Scale Towards Problem-solving

		Reflective Thinking Skill Scale			
		p-total	p-questioning	p-reasoning	p-evaluation
Mathematics anxiety	Pearson Correlation (r)	–.289**	–.242**	–.313**	–.214**
	Sig. (2-tailed) *(p)*	0.000	0.000	0.000	0.000
	N	779	779	779	779

A significant negative relationship exists between students' reflective thinking skill scores and subscale scores towards problem-solving and their mathematics anxiety scores (see Table 12). A multiple regression analysis was performed to see to what extent the reflective thinking skill for problem-solving predicted math anxiety. And it was found that the *reasoning* sub-dimension of the reflective thinking skill for problem-solving predicted math anxiety by 10%. The findings are shared in detail in Table 13.

Table 13

Regression Analysis Results on the Effect of Reflective Thinking Skills for Problem-Solving on Mathematics Anxiety

Variable	B	SE	*β*	*t*	*p*	*R*	Adj. R^2	*F*	*p*
Constant	40.779	2.020	-0.238	20.141	0.000	0.316	0.096	28.559	0.000
P-reasoning	-0.793	0.264		-3.008	0.003				

Note. Dependent variable= mathematics anxiety

Multiple regression analysis did not produce statistically significant results ($p>.05$) for the coefficients of *p-questioning*, *p-evaluation*, and *p-total scores*. Only *p-reasoning* was included in Table 13 since its coefficient was statistically significant in the model ($p<.05$). As seen in the table, 10% of the total variance of mathematics anxiety is explained by the *reasoning* sub-dimension of the reflective thinking skill scale towards problem-solving.

4. Conclusion and Discussion

This study aimed to investigate the relationship between the reflective thinking abilities of 8th-grade students in middle school and their level of math anxiety, with a focus on problem-solving. Using the simple random sampling method, 779 students who received education in Istanbul were reached in this study. In the study, we analyzed the average scores of the reflective thinking skill scale related to problem-solving, the sub-dimensions of this scale, and the mathematics anxiety scale. We examined these scores based on various variables, including gender, the mother's education level, the father's education level, and the type of game played.

The averages of the scores obtained from the reflective thinking skill scale towards problem-solving and its sub-dimensions exhibit a statistically significant gender difference, favoring female students. In the master's thesis, Altuntaş (2019) reported a similar result. Şanlıdağ (2020) emphasizes that students who take brain game lessons develop better critical thinking and problem-solving skills than those who do not. According to Bilgiç's (2017) master's study, there was no significant difference in the reflective thinking skills of seventh-grade students towards problem-solving based on the educational status of their parents, including both the mother and father. Saygılı and Atahan (2014) conducted a study to examine the reflective thinking skills of children aged 8 to 10 years old in relation to several variables, including gender, computer game usage, and parental education levels. The study revealed no statistically significant differences in the mean total and sub-dimension scale scores based on gender, computer gaming usage, and parental education level. Whereas, in our study, students who play brain games have significantly higher reflective thinking skills towards problem-solving than students who prefer to play adventure, war, and other games. It is noteworthy that there is a significant difference in the average scores of reflective thinking skills related to problem-solving among students who play adventure games and those who play war games. These findings are surprising and highlights the impact of different types of games on cognitive abilities.

Our study revealed that gender, father's educational level, and type of play games are independent variables that impact mathematics anxiety. Adal (2017) examined students' self-efficacy perceptions and mathematics anxieties and found no significant difference between mathematics anxieties and gender. Furthermore, Ergenç (2011) analyzed 7th-grade students to investigate the potential correlation between students' cognitive readiness levels for mathematics classes and their levels of mathematics anxiety. The results indicate that gender did not have a statistically significant impact on the determination of mathematics anxieties. Similar findings have been observed in the studies conducted by Yenilmez and Özbey (2006) and Akgül (2008).

Tan (2015) stated in their study that students whose fathers have a university degree have lower mathematics anxiety scores at anxiety levels according to the fathers' degree variable. In our research, it was found that there are similar results between the two groups. It was identified that students whose fathers have a high school degree or a higher degree have lower anxiety levels than students whose fathers have a primary school degree or a lower degree. Ergenç (2011) highlighted that students whose parents have a university degree are less worried than other students are.

Uysal (2007) employed similar variables in her study about analyzing the correlation between middle school students' problem-solving skills, anxieties, and attitudes in mathematics classes. It was concluded as a result of the study that female students are more

worried than male students. This conclusion is parallel to our study results. It was determined in the same study that male students are better at problem-solving than female students. This result fits with the purposes of our results. It was concluded in our study that there is a meaningful difference in favor of female students in all the other scores. Uysal concluded in her study that parents' degree does not have an effect on students' mathematics anxieties and problem-solving skills. In our study, the father's educational status variable is a significant factor with a weak effect size for math anxiety scores.

According to the current study, there is a weak negative correlation between average scores of the reflective thinking skill scale towards problem-solving and its sub-dimensions and average scores of mathematics anxieties. In the resulting regression analysis model, 10% of the total variance of mathematics anxiety is explained by the reasoning sub-dimension of the reflective thinking skill scale towards problem-solving.

The striking finding in the study is that students' scores on both scales differed significantly according to the games they preferred to play. Demirel and Karakuş-Yılmaz (2019) emphasized that playing mind games (sudoku, puzzle, etc.) increases success in mathematics and grammar lessons and improves problem-solving skills. Studies have indicated that strategic video games can positively affect problem-solving skills. Regular engagement with these games may improve cognitive abilities such as spatial reasoning, attentional control, working memory, and information processing speed. These skills can, in turn, transfer to real-world problem-solving scenarios (Adachi & Willoughby, 2013). This situation seems like a good option to examine in detail for future study.

ACKNOWLEDGEMENT
—

FUNDING
No financial support was received from any person or institution for the study.

ETHICS
The authors declare that this article complies with the ethical standards and rules. The Ethics Committee of Sabahattin Zaim University authorized this study with a decision dated November 30, 2022, assigned the number 2022/10. Furthermore, the Istanbul Governorship Provincial Directorate of National Education gained permission to conduct the survey and research by letter dated January 25, 2023, bearing the number E-59090411-44-69277272.

AUTHOR CONTRIBUTION
Süruri Selim Erdem | Literature review; Drafting; Data collection/analysis; Interpretation of data/findings; Final approval and accountability. Contribution rate 36%

Elif Esra Arıkan | Concept/idea; Literature review; Design; Drafting; Data collection/analysis; Interpretation of data/findings; Supervising; Critical review; Final approval and accountability. Contribution rate 64%

CONFLICT OF INTEREST
The authors declare no conflict of interest.

References

Adachi, P. J. C., & Willoughby, T. (2013). More than just fun and games: The longitudinal relationships between strategic video games, Self-reported problem solving skills, and academic grades. *Journal of Youth and Adolescence*, *42*(7), 1041–1052. https://doi.org/10.1007/s10964-013-9913-9

Adal, A. A. (2017). *Ortaokul öğrencilerinin matematik öz yeterlik algıları ile matematik kaygı düzeyleri arasındaki ilişki* [The relationship between mathematics self-efficacy and mathematics anxiety levels of middle school students] (Yayın No. 469621) [Yüksek lisans tezi, Marmara Üniversitesi]. Yükseköğretim Kurulu Başkanlığı Tez Merkezi.

Akgül, S. (2008). *İlköğretim ikinci kademe 7. ve 8. sınıf öğrencilerinin matematik kaygıları ile algıladıkları öğretmen sosyal desteğinin cinsiyete göre matematik başarılarını yordama gücü* [The predictive power of mathematics anxiety and perceived teacher social support of 7th and 8th-grade elementary school students' mathematics achievement by gender] (Yayın No. 231324) [Yüksek lisans tezi, Yıldız Teknik Üniversitesi]. Yükseköğretim Kurulu Başkanlığı Tez Merkezi.

Altuntaş, L. (2019). *İlköğretim 7. sınıf öğrencilerinin matematik dersinde problem çözmeye yönelik yansıtıcı düşünme becerileri ile matematik dersine yönelik tutum ve başarıları arasındaki ilişkinin incelenmesi* [Examining the relationship between math achievement, math attitudes, and reflective thinking skills toward problem-solving of the 7th-grade students] (Yayın No. 584605) [Yüksek lisans tezi, Yıldız Teknik Üniversitesi]. Yükseköğretim Kurulu Başkanlığı Tez Merkezi.

Bilgiç, C. (2017*). İlköğretim öğrencilerin problem çözmeye yönelik yansıtıcı düşünme becerileri ve sosyal bilgiler dersi akademik başarıları* [Reflective thinking skills of elementary school students to solve problems, social studies, and academic achievements] (Yayın No. 477021) [Yüksek lisans tezi, Uşak Üniversitesi]. Yükseköğretim Kurulu Başkanlığı Tez Merkezi.

Bindak, R. (2005). İlköğretim öğrencileri için matematik kaygı ölçeği [Math anxiety scale for elementary school students]. *Fırat Üniversitesi Fen ve Mühendislik Bilimleri Dergisi, 17*(2), 442–448. https://toad.halileksi.net/wp-content/uploads/2022/07/ilkogretim-ogrencileri-icin-matematik-kaygi-olcegi-toad.pdf

Büyüköztürk. Ş., Kılıç-Çakmak, E., Akgün, Ö. E., Karadeniz, Ş., & Demirel, F. (2020). *Bilimsel araştırma yöntemleri* (29. bs.). Pegem Atıf İndeksi.

Charles, R., & Lester, F. (1982). *Teaching problem-solving: What, why & how*. Dale Seymour Publications.

Dede, Y., & Yaman, S. (2005). Matematik öğretmen adaylarının matematiksel problem kurma ve problem çözme becerilerinin belirlenmesi [Identification of mathematics problem-posing and problem-solving skills for prospective mathematics teachers]. *Eurasian Journal of Educational Research*, 18, 41–56. https://hdl.handle.net/20.500.12418/1554

Demirel, T., & Karakus Yilmaz, T. (2019). The effects of mind games in math and grammar courses on the achievements and perceived problem-solving skills of secondary school students. *British Journal of Educational Technology*, *50*(3), 1482–1494. https://doi.org/10.1111/bjet.12624

Ergenç, T. S. (2011). *İlköğretim yedinci sınıf öğrencilerinin matematik dersi bilişsel hazır bulunuşluk düzeyleri ile matematik kaygı düzeyleri arasındaki ilişkinin incelenmesi* [The investigation of the relationship between the level of readiness in Maths and the level of Maths anxiety of the 7th-grade students] (Yayın No. 296472) [Yüksek lisans tezi, Osmangazi Üniversitesi]. Yükseköğretim Kurulu Başkanlığı Tez Merkezi.

Furner, J. M., & Duffy, M. L. (2002). Equity for all students in the new millennium: Disabling math anxiety. *Intervention in School and Clinic*, *38*(2), 67–74. https://doi.org/10.1177/10534512020380020101

Günen, A. (2019). *8. sınıf öğrencilerinin problem çözmeye yönelik yansıtıcı düşünme becerileri ile fen bilimleri rutin ve rutin olmayan problem çözme düzeyi arasındaki ilişki* [The relationship between thinking skills intended for problem-solving of 8th-grade students and the level of routine and non-routine problem solving] (Yayın No. 576433) [Yüksek lisans tezi, Kocaeli Üniversitesi]. Yükseköğretim Kurulu Başkanlığı Tez Merkezi.

Kailani, S., Newton, R., & Pedersen, S. (2019). Game-based learning and problem-solving skills: A systematic review of the literature. In J. Theo Bastiaens (Ed.), *Proceedings of EdMedia + Innovate Learning* (pp. 1127–1137). Association for the Advancement of Computing in Education (AACE). Retrieved January 7, 2020 from https://www.learntechlib.org/primary/p/210119/.4

Kızılkaya, G., & Aşkar, P. (2009). Problem çözmeye yönelik yansıtıcı düşünme becerisi ölçeğinin geliştirilmesi. *Eğitim ve Bilim*, *34*(154), 82–92. http://egitimvebilim.ted.org.tr/index.php/EB/article/view/550

Ministery of Education. [MEB]. (2018). *Matematik dersi öğretim programı (ilkokul ve ortaokul 3. 4. 5. 6. 7 ve 8. sınıflar)* [Mathematics teaching program (primary and middle school 3rd, 4th, 5th, 6th, 7th, and 8th grades)]. Millî Eğitim Bakanlığı.

Oluk, A., & Çakır, R. (2019). Üniversite öğrencilerinin bilgisayarca düşünme becerilerinin mantıksal matematiksel zekâ ve problem çözme becerileri açısından incelenmesi [Investigating university students' computational thinking skills in terms of logical-mathematical intelligence problem-solving skills]. *Kuramsal Eğitimbilim Dergisi*, *12*(2), 457–473. https://doi.org/10.30831/akukeg.351312

Piggott, J. (2011). *Cultivating creativity*. NRICH. Retrieved April 22, 2023, from https://nrich.maths.org/5784

Rossnan, S. (2006). Overcoming math anxiety. *Mathitudes*, *1*(1), 1–4.

Saygılı, G., & Atahan, R. (2014). Üstün zekâlı çocukların problem çözmeye yönelik yansıtıcı düşünme becerilerinin çeşitli değişkenler bakımından incelenmesi [Analyzing reflective thinking skills towards problem-solving of gifted children in terms of various variables]. *Süleyman Demirel Üniversitesi Fen-Edebiyat Fakültesi Sosyal Bilimler Dergisi*, *2014*(31), 181–192. https://dergipark.org.tr/tr/pub/sufesosbil/issue/11406/136178

Silver, E. A., & Marshall, S. P. (1990). Mathematical and scientific problem solving: Findings, issues, and instructional implications. In B. F. Jones & L. Idol (Eds.), *Dimensions of thinking and cognitive instruction* (pp. 265–290). Lawrence Erlbaum Associates, Inc.

Şanlıdağ, M. (2020). *Zekâ oyunları dersinin öğrencilerin matematik problemi çözme tutumlarına ve problem çözmeye yönelik yansıtıcı düşünme becerilerine etkisi* [The effect of intelligence games on students' attitudes toward solving mathematical problems and reflective thinking skills for problem-solving] (Yayın No. 644936) [Yüksek lisans tezi, Muğla Sıtkı Koçman Üniversitesi]. Yükseköğretim Kurulu Başkanlığı Tez Merkezi.

Tan, M. N. (2015). *Ortaokul öğrencilerinin matematik kaygısı öğrenilmiş çaresizlik ve matematiğe yönelik tutum düzeyleri arasındaki ilişkilerin incelenmesi* [The investigation of the relationships among mathematics anxiety, learned helplessness, and attitudes toward mathematics in middle school students] (Yayın No. 407580) [Yüksek lisans tezi, Necmettin Erbakan Üniversitesi]. Yükseköğretim Kurulu Başkanlığı Tez Merkezi

Toluk, Z., & Olkun, S. (2002). Türkiye'de matematik eğitiminde problem çözme: İlköğretim 1.-5. sınıflar matematik ders kitapları [Problem-solving in Türkiye's mathematics education: Mathematics course books for primary school 1st-5th grades]. *Kuram ve Uygulamada Eğitim Bilimleri / Educational Sciences: Theory & Practice*, *2*(2), 563–581. http://acikerisim.ibu.edu.tr/xmlui/handle/20.500.12491/2328

Uysal, O. (2007). *İlköğretim II. kademe öğrencilerinin matematik dersine yönelik problem çözme becerileri, kaygıları ve tutumları arasındaki ilişkilerin değerlendirilmesi* [Evaluation of the relationship between problem-solving skills, anxiety, and attitudes of secondary education 2nd-grade students directed toward mathematics courses] (Yayın No. 211583) [Yüksek lisans tezi, Dokuz Eylül Üniversitesi]. Yükseköğretim Kurulu Başkanlığı Tez Merkezi

Wilson, J. W., Fernandez, M. L., & Hadaway, N. (1993). Mathematical problem solving. In P. S. Wilson (Ed.), *Research ideas for the classroom: High school mathematics* (pp. 57–78). Macmillan.

Yenilmez, K., & Özbey, N. (2006). Özel okul ve devlet okulu öğrencilerinin matematik kaygı düzeyleri üzerine bir araştırma. [A study on public and private school students' mathematics anxiety levels]. *Uludağ Üniversitesi Eğitim Fakültesi Dergisi*. *19*(2), 431–448. https://dergipark.org.tr/tr/pub/uefad/issue/16684/173379