The Relationship between Middle School Students' Metacognitive Awareness and Their Attitudes to Mathematics

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Abstract: This study aims to examine the relationship between middle school students' metacognitive awareness and their mathematics attitudes. The relational research model, one of the quantitative research methods, was used in the research. The study group of the research consists of 166 male and 184 female students studying in the fifth, sixth, seventh, and eighth grades of a middle school located in the east of Turkey. Metacognition awareness scale and attitude towards mathematics scale were used as data collection tools in the research. In the analysis of the data, the independent t-test was used to compare two independent groups, and the relationship between the variables was examined with the Pearson correlation coefficient. The results show that there is a positive and significant relationship between the metacognitive awareness of middle school students and their attitudes toward mathematics. It was determined that there was no significant difference between students' metacognitive awareness and mathematics attitudes according to their gender, only the problem-solving sub-dimension score values of the attitude scale differed significantly in favor of female students.

Keywords: Metacognition, Metacognitive awareness, Math attitude

1. Introduction

The rapid developments in today's world have led to the change and development of education in every field. It has become important to raise individuals who can produce information and use information effectively, solve problems, and have advanced critical thinking skills (MEB, 2018). It has become important to choose and use the right information in the rapidly changing and developing information stack every day. Therefore, today's education system aims to raise individuals who can think, analyze and offer different solutions (Arsuk & Sezgin Memnun, 2020). When we look at the main purposes of mathematics education, it is emphasized to raise individuals who can think, interpret what they think, what they think, and how they think (MEB, 2017).

Negative attitudes towards mathematics cause mathematics to be seen as a difficult and difficult subject to understand. Students' attitudes towards mathematics are defined as positive or negative emotional reactions towards mathematics, confidence in being successful in mathematics learning, and strategies for coping with mathematics problems (Ajisuksmo & Saputri, 2017). Previous research on mathematics has revealed that attitudes toward mathematics have an important role in determining mathematics learning success. It has been stated that students with positive attitudes towards mathematics will get high scores in mathematics (Doruk, Öztürk & Kaplan, 2016; Katrancı & Şengül, 2019; Lewis & Aiken, 1970; Öztürk, Akkan & Kaplan, 2020).

Students' attitudes affect their cognitive activities. Students who have a positive attitude towards mathematics become aware of the importance of mathematics. It is known that teaching based on metacognition helps students to develop their mathematical thinking, to be aware of their thinking processes, and evaluate and organize this process (Şahinkaya, Öztürk & Albayrak; 2022). In research in which metacognition-based teaching is carried out; It has been stated that students with high problem-understanding skills and self-confidence develop positive attitudes towards mathematics (Pehlivan, 2012; Tuncer & Yılmaz, 2016). It is known that individuals who develop positive attitudes towards mathematics have high mathematical achievements and metacognitive skills (Demirkıran, Elalmış & Doğan; 2023; Memiş & Arıcan, 2013; Özsoy & Günindi, 2011).

In the mathematics curriculum of MEB (2021), it is emphasized that students with high mathematics achievement are individuals who have high metacognitive skills and develop positive attitudes toward mathematics. The American National Council of Mathematics Teachers (NCTM, 2000) stated that among the goals of mathematics, students should develop positive attitudes towards mathematics and be more successful individuals in mathematics by improving their metacognitive awareness skills. In this study, the relationship between middle school students' metacognitive awareness and their attitudes toward mathematics was examined, and it is expected to make an important contribution to the literature on mathematics education in terms of revealing the relationship between middle school students' metacognitive awareness and their attitudes towards mathematics.

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1.1. Theoretical Framework

1.1.1. Metacognition and Metacognitive Awareness

Metacognition has been discussed as a concept by researchers working in the field of educational psychology since the 1970s (Şahinkaya, Öztürk & Albayrak., 2021). John Flavell (1976), who used the concept of metacognition for the first time, defined metacognition as an individual's having knowledge of his cognitive processes and controlling and regulating his cognitive processes with this knowledge. Metacognition means the individual's internal observation of the characteristics, structure, and functioning of his cognitive processes. is also coming. It is seen that individuals who are aware of these processes have high metacognitive skills (Demircioğlu, 2006). Individuals with high metacognitive skills have a high ability to control their thinking processes, that is, metacognitive awareness (Reeve & Brown; 1985). It is seen that individuals with high metacognitive awareness are more successful in planning their learning, that is, they have high-level skills in learning to learn (Çakıroğlu, 2007). Metacognitive awareness enables students to plan, monitor and evaluate their learning (Schraw & Dennison, 1994). Thus, the student who takes responsibility for all parts of the learning process applies what he knows more easily to the problems he encounters and becomes successful (Schraw & Dennison, 1994). It is also seen that these individuals are more successful in the administrative processes they use to solve the problems they encounter in daily life (Sternberg 1988).

Learners should be aware of how to organize and use information effectively (Zimmerman, 2008). Metacognitive awareness is concerned with individuals' awareness of where they are in the learning process or in solving a problem, their context-specific knowledge, and personal learning or problem-solving strategies. (Wilson & Clarke, 2004). Students with metacognitive awareness can gain awareness of their thoughts and learn to cope with problems when they encounter them (Hoyt & Sorensen, 2001; Peverly, Brobst, & Morris, 2002).

In addition to the metacognitive skills that are effective in the planning of the individual's learning process, many factors affect this process. One of these factors is the attitude factor. The concept of attitude is closely related to students' readiness levels and their belief in learning (Sarpkaya, Gözdegül & Kaplan; 2011).

1.1.2. Mathematics Attitude

An individual with metacognitive awareness is expected to exhibit cognitive behaviors. In addition to having cognitive skills such as problem-solving and reasoning, they are also expected to develop positive attitudes toward mathematics and have self-confidence (Doruk, Öztürk, & Kaplan, 2016). Attitude is defined as the tendency of individuals to react positively or negatively toward a certain object (Turgut, 1978). Mathematics attitude is defined as a total measure of liking or disliking mathematics, dealing with or avoiding mathematical activities, the belief that one will be good or bad in mathematics, and the belief that mathematics is useful or useless (Ma & Kishor, 1997). Developing a positive attitude towards mathematics and building self-confidence are among the general objectives of the curriculum (MEB, 2018). In the mathematics education program, the relationship between interest, attitude, and motivation was emphasized. It has been underlined that there should be an interest in the lesson to provide mathematics motivation, and it has been stated that students with high interest and motivation can develop a positive attitude toward the lesson (MEB, 2018). Attitude not only plays an important role in the learning and teaching process of the mathematics lesson but also affects the mathematics achievement of the students (Farooq & Shah, 2008). Students' attitudes towards mathematics make them aware of their mathematical competence and have a great impact on their mathematics achievement (Soni & Kumari, 2017). It is known that there is a positive relationship between students' attitudes towards mathematics and their mathematics achievement and that students with positive attitudes are more successful in academic terms (Aiken, 1970; Ma, 1997).

1.2. Literature Review

When the studies on attitude towards mathematics are examined, it is seen that the focus is on determining the relationship between attitude and variables such as mathematics self-confidence, mathematics self-efficacy, mathematics achievement, and metacognitive awareness (Öztürk & Serin, 2020; Kandal & Baş, 2021; Gürel & Bozkurt, 2023; Karaşan, 2019; Ajan, Luna & Roble, 2021; Öztürk, Akkan & Kaplan 2020). When the studies on metacognitive awareness are examined, there are studies examining the relationship between attitude, motivation, and different strategies, and studies modeling problem-solving with metacognitive strategies (Deniz, 2019; Küçükakça, 2021; Arslan, 2021; Filiz & Gür, 2020). This study was conducted to examine the relationship between middle school students' metacognitive awareness and their attitudes toward mathematics. When the studies on this theme in the related literature are examined, there are studies examining the relationship between students' metacognitive awareness and their mathematics achievement, anxiety, and fear (Deniz, 2019; Sarpkaya et al. 2011; Arsuk & Sezgin Memnun,2020; Kandal & Baş, 2021). In addition to these studies, there are also studies on the relationship between pre-service teachers' awareness of metacognitive thinking and their self-efficacy, their concerns about teaching mathematics, and their perceptions of teacher efficacy (Öztürk & Serin, 2020; Baykara,2011; Tunca & Alkın-Şahin, 2014; Deniz, 2017).

Sarpkaya et al. (2011) found that there is a positive relationship between pre-service teachers' metacognitive awareness and attitudes toward mathematics in their study. They concluded that there was no significant difference between pre-service teachers' attitudes toward mathematics and their awareness of using metacognitive strategies according to their gender. Accordingly, students with high academic achievement have positive attitudes toward mathematics and better metacognitive awareness. Kandal and Baş (2021) conducted a study on middle school students' levels of metacognitive awareness, self-regulatory learning strategies, anxiety, and attitude toward mathematics predicting mathematics achievement. In their study, they found that there was a positive and very high correlation between middle school students' metacognitive awareness and mathematics achievement. They concluded that there was no significant difference between middle school students' attitudes toward mathematics and their awareness of using metacognitive strategies according to their gender. Kaya (2019), in his study examining the factors that predict the success of middle school students, found that metacognitive awareness plays a significant mediating role in success, students who use their cognitive skills effectively have a positive attitude towards mathematics and increase their mathematics achievement. Küçükakça (2021), in his study to examine the effect of using metacognitive strategies in the 6th-grade mathematics lesson on students' metacognitive awareness and attitudes towards mathematics, concluded that teaching using metacognitive strategies in the mathematics lesson did not contribute to the development of students' attitudes towards mathematics.

When the literature is examined, studies examining the relationship between metacognitive awareness and mathematics attitude have generally focused on teacher candidates and not many studies have been conducted on students. When the research is examined, many variables that are thought to be related to cognitive awareness are seen as an important subject to be investigated and many studies have been conducted on these concepts. When the literature was examined, few studies were found that examined middle school students' awareness of using metacognitive strategies and their attitudes toward mathematics. For this reason, it is thought that the results obtained from the designed research will shed light on mathematics education, teachers, and researchers. In this direction, the research was carried out to examine the relationship between the metacognitive awareness of middle school students and their mathematics attitudes. In line with this purpose, answers to the following research questions and hypotheses will be sought:

1. Is there a significant relationship between the metacognitive awareness of middle school students and their mathematics attitudes?

H1.There is a significant relationship between middle school students' metacognitive awareness and their mathematics attitudes.

2. Is there a significant relationship between middle school students' metacognitive awareness scale sub-dimension scores and mathematics attitude scale sub-dimension scores?

H2. There is a significant relationship between middle school students' metacognitive awareness scale sub-dimension scores and mathematics attitude scale sub-dimension scores.

3. Does the metacognitive awareness of middle school students differ significantly according to gender?

H3. The metacognitive awareness of middle school students differs significantly according to gender.

4. Do middle school students' attitudes towards mathematics differ significantly by gender?

H4. Middle school students' attitudes towards mathematics differ significantly by gender.

2. Method

In this section, information about the research model, participants, data collection tools and data analysis will be given.

2.1. Research model

In this study, the relational research model, one of the quantitative research methods, was used. The relational research model is aimed to determine the relationship between two or more variables and obtain clues about cause and effect (Fraenkel, Wallen & Hyun, 2012). In general, the person conducts the research to find and define the relationships that may exist between the naturally occurring phenomena, without trying to change these phenomena in any way (Büyüköztürk et al., 2020). In this study, the relational research model was used since it aimed to examine the relationship between students' metacognitive awareness and mathematics attitudes.

2.2. Participants

The simple random sampling method, one of the random sampling methods, was used in the selection of the sample of the study. This sampling method is based on the random grouping of the units that make up the universe, and the random selection of a certain number of groups from among the groups (Fraenkel, Wallen & Hyun, 2012). In this method, where the power of the sample is high to represent the universe, it is aimed to

include the selected units in the sample by giving each sample an equal probability of being selected. (Büyüköztürk et al., 2020).

The sample of the research consists of fifth, sixth, seventh, and eighth-grade students studying in a middle school in eastern Turkey. In the selection of the sample, all middle schools in the province were listed and one of these schools was selected following the simple random sample. Of the 350 students who participated in the research, 52% were female students and 48% were male students. 28% of the students are in 5th grade, 24% are in 6th grade, 22% are in 7th grade and 26% are 8th-grade students. 25% of male students are in 5th grade, 26% are in 6th grade, 22% are in 7th grade and 22% are 8th-grade students. 30% of the female students are in 5th grade, 22% are in 6th grade, 21% are in 7th grade and 27% are 8th-grade students.

2.3. Data collection tools

In this research, the 'Mathematics Attitude Scale for Primary and Middle school Students' developed by Gülburnu and Yıldırım (2015) and the 'Mathematical Metacognition Awareness Scale' developed by Duran and Kaplan (2016) were used as data collection tools.

2.3.1. Mathematical Metacognition Awareness Scale

The Mathematical Metacognition Awareness Scale developed by Duran and Kaplan (2016) was used to determine the metacognitive awareness of middle school students. The 5-point Likert -type scale consists of 23 items and 3 dimensions. These dimensions were named 'mathematical knowledge', 'mathematical tracking', and 'mathematical detection'. Each item on the scale was rated as "never", "rarely", "sometimes", "often" and "always". All of the items in the scale are positive items. Item-total correlations of the scale. It ranged from 446 to .609. Researchers calculated the internal consistency coefficient of the scale as ( ). As a result of the factor analysis performed to determine the construct validity of the scale, it was explained that the factor loads of the scale items varied between 0.42 and 0.76. It was stated that the three factors in the scale explained 43.12% of the total variance. In this study, it was calculated as the internal consistency coefficient. Examples of the items in the scale are "I am aware of what I say when describing the parts and place values of a natural number", "I am sure of solving problems related to exponential numbers" and "I am aware of what I am trying to do when interpreting the data shown with a column chart".

2.3.2. Mathematics Attitude Scale

The Mathematics Attitude Scale developed by Gülburnu and Yıldırım (2015) was used to determine middle school students' attitudes toward mathematics. The 5-point Likert -type scale consists of 27 items and 5 dimensions. These dimensions are named "In-Class", "Nature of Mathematics", "Problem-Solving", "Comprehension", and "Self-efficacy". Each student responds to each item in the scale in five subscales. These; are "Strongly agree, Agree, Undecided, Disagree, strongly disagree". Three of these items are negative items for attitude. As a result of the factor analysis performed to determine the construct validity of the scale, it was explained that the factor loads of the scale items varied between 0.44 and 0.75. It was stated that the five factors in the scale explained 49,093% of the total variance. Researchers calculated the internal consistency coefficient of the scale as. In this study, the internal consistency coefficient was calculated as .91. The items in the scale; Examples are "Math makes me feel comfortable", "Math is my favorite subject", "I don't want my math classes to end" and "Math is a headache for me".

2.4. Data Analysis

All data is on the computer with SPSS (statistical package for social sciences) for Windows 22 program was recorded and analyzed. In order to decide which tests (parametric/ nonparametric tests) will be applied first in the analysis of the data, the assumptions that must be met are tested. In order to decide the normality of the distribution, Kolmogorov-Smirnov, the other assumptions of the normal distribution, kurtosis and skewness values and histogram graph were used. T-test in comparison of two independent groups (Independent sample t-test) was used. The relationship between the variables was examined with the Pearson correlation coefficient. The significance level of 0.05 was used as a criterion in interpreting whether the obtained values were significant or not.

Mathematical metacognition awareness and math attitude levels were evaluated by calculating the group width (4/5=.80) formula. To this end; "very low" between 1.00-1.80; 1.80-2.60 "low level"; 2.60-3.40 "intermediate"; 3.40-4.20 "high level"; A range of 4.20-5 was taken as "very high".

The relationship between the scales and the sub-dimension scores was examined using the Pearson correlation coefficient. The correlation coefficient (r) takes values ranging from -1 to +1 and these values show the direction and strength of the relationship. A value of (-) of the correlation coefficient indicates that the relationship between the variables is inversely proportional, and a value of (+) indicates that it is directly proportional, while it is seen that the strength of the relationship increases as the value of the coefficient

approaches ± 1, and decreases as it approaches 0 (Durmuş et al., 2013:144). Correlation degree was based on ±1 ≤ r ≤ ± 0.7 Strong Relationship, ±0.7 ≤ r ≤ ± 0.3 Medium Relationship, ±0.3 ≤ r ≤ ± 0 Weak Relationship. (Gürbüz and Şahin, 2018).

2.5. Examining the Suitability of the Data to the Normal Distribution

Kolmogorov-Smirnov test and kurtosis skewness values were analyzed and evaluated in order to determine the relationship between middle school students' attitudes towards mathematics and their awareness of metacognition, and the results are given in Table 3.

Table 3. Examining the Suitability of the Data to the Normal Distribution

	Kolmogorov-Smirnov			**Skewness**	**Kurtosis**
	Statistics	df	p		
Mathematical knowledge	0.11	350	0.01	-0.43	-0.67
Mathematical tracking	0.06	350	0.01	-0.13	-0.10
Mathematical determination	0.10	350	0.01	-0.22	-0.68
Mathematical metacognition awareness scale	0.09	350	0.01	0.01	-0.73
In-class	0.13	350	0.01	-0.49	-0.71
Competence	0.16	350	0.01	-0.55	-0.53
Understanding	0.14	350	0.01	-0.29	-0.63
Problem solving	0.12	350	0.01	-0.64	0.57
Nature of mathematics	0.15	350	0.01	-0.52	-0.59
Mathematics Attitude Scale	0.12	350	0.01	-0.46	-0.76

Statistical analyzes were performed with parametric tests, considering that the values of kurtosis and skewness were between ±2.0 (George and Mallery, 2010) in the data with a significance level less than 0.05 obtained from the Kolmogorov-Smirnov test.

3. Results

In this section, the analyzes applied for the data collected for the answers to the questions addressed in the study, the results and interpretations of the findings obtained as a result of the analyzes are given.

3.1. Findings Related to Mathematical Metacognition Awareness and Mathematics Attitude Levels

The frequency values of the scores obtained from the scales were used to examine the distribution of students' mathematical metacognitive awareness and mathematics attitude levels. In Table 4, the distribution of students' metacognitive awareness and mathematics attitude levels is presented as frequency values.

Table 4. Distribution of Mathematical Metacognition Awareness and Mathematics Attitude Levels

Scale and Dimensions	**Level**	**n**	**%**
Mathematical metacognition awareness scale	low level	10	2.86
	Intermediate	165	47.14
	high level	120	34.29
	very high level	55	15.71
Mathematics Attitude Scale	very low level	one	0.29
	low level	30	8.57
	Intermediate	88	25.14
	high level	131	37.43
	very high level	one hundred	28.57

When Table 4 is examined, 47.14% (n:165) of middle school students' metacognitive awareness levels are medium-level, 34.29% (n:120) high-level and 15.71% (n:55) very high. they have been detected. When the mathematics attitude levels were examined, it was determined that 37.43% (n:131) of the individuals were at high level, 28.57% (n:100) were at very high level, and 25.14% (n:88) were at medium level.

3.2. Comparison of Scale Scores by Gender

A t-test analysis was performed to determine whether there was a difference between attitudes towards mathematics and metacognitive awareness of the gender factor in the sample, and the results are given in Table 5 and Table 6, respectively.

Table 5. Comparison of Mathematical Metacognition Awareness Scale and Sub-Dimension Scores by Gender

Variable	Group	N	$\bar{X}$±Sh	t	p
Mathematical Knowledge	Girl	184	3.79±0.77	-0.82	0.41
	Male	166	3.85±0.68		
Mathematical Tracing	Girl	184	3.49±0.64	0.77	0.44
	Male	166	3.43±0.68		
Mathematical Detection	Girl	184	3.21±0.88	1.78	0.08
	Male	166	3.05±0.81		
Mathematical Metacognition Awareness Scale	Girl	184	3.51±0.61	0.72	0.47
	Male	166	3.46±0.58		

Note. t: Independent sample t test

According to Table 5, it is seen that the average scores of male and female middle school students for their metacognitive awareness are higher in favor of female students when the whole scale is taken as a basis. However, according to the results of the independent groups t-test performed to determine the significance of the said mean difference, it was determined that the statistical difference in favor of female students did not show a significant difference (t348=0.72, p>.05) and "mathematical knowledge" (t348). =-0.82, p<.05) dimensions, "mathematical tracking" (t348=-0.77, p>.05) and "mathematical detection" (t348=-1.78, p>.05) dimensions It was also determined that there was no significant difference in favor of female students (p>0.05). According to the findings, it was determined that the mathematical metacognitive awareness of female and male students was similar.

Table 6. Comparison of Mathematics Attitude Scale and Sub-Dimension Scores by Gender

Variable	Group	n	$\bar{X}$±Sh	t	p
In-class	Male	184	3.74±0.82	0.06	0.96
	Girl	166	3.73±0.81		
Competence	Male	184	3.76±0.94	0.52	0.60
	Girl	166	3.70±0.93		
Understanding	Male	184	3.42±1.00	-0.30	0.76
	Girl	166	3.46±0.95		
Problem solving	Male	184	3.84±0.71	2.27	0.02
	Girl	166	3.66±0.76		
nature of mathematics	Male	184	3.68±0.94	0.98	0.33
	Girl	166	3.58±0.98		
Mathematics Attitude Scale	Male	184	3.73±0.72	0.78	0.43
	Girl	166	3.67±0.73		

According to Table 6, it is seen that the average scores of female and male middle school students towards mathematics attitudes are higher in favor of male students when the whole scale is taken as a basis, except for the "understanding" dimension. When Table 6 is examined, "in-class" (t348=0.06, p>.05), "proficiency" (t348=0.52, p>.05), "nature of mathematics" (t348=0.98, p>). 05) and mathematics attitude general scores (t348=0.78, p>.05) did not show a statistically significant difference according to the gender of the individuals. Mathematics attitude scale problem solving sub-dimension scores show a statistically significant difference according to the gender of the individuals (t348=2.72; p<0.05). Looking at the mean values, it was determined that the problem solving scores of the girls (3.66±0.76) were higher than the boys (3.84±0.71).

3.3. Comparison of Scale Sub-Dimension Scores

The correlation between the sub-dimension scores of the scale was examined with the Pearson correlation coefficient, and the results are presented in Table 7.

Table 7. Findings Regarding the Relationship Between Scales

		In-class	Competence	Understanding	Problem solving	Nature of mathematics	Mathematics Attitude Scale
Mathematical	R	0.41	0.35	0.42	0.46	0.30	0.45
Knowledge	P	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**
Mathematical	R	0.33	0.30	0.30	0.44	0.37	0.41
Tracing	P	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**
Mathematical	R	0.16	0.15	0.09	0.33	0.29	0.25
Detection	P	**0.01**	**0.01**	0.08	**0.01**	**0.01**	**0.01**
Mathematical	R	0.37	0.32	0.34	0.51	0.38	0.45
Metacognition	P	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**
Awareness Scale							

When Table 7 is examined, it is seen that there is a positive, moderately statistically significant relationship between the scores of mathematical knowledge and general scores of in-class, proficiency, comprehension, problem solving, nature of mathematics and mathematics attitude scale (R:0.41 r:0.35, respectively). r:0.42 r:0.46 r:0.30 r:0.45; $p<0.05$).

It is seen that there is a positive and moderately statistically significant relationship between the mathematical monitoring scores and the general scores of in-class, proficiency, comprehension, problem solving, nature of mathematics and mathematics attitude scale. (Respectively r:0.33 r:0.30 r:0.30 r:0.44 r:0.37 r:0.41; $p<0.05$).

It is seen that there is a low level of statistically significant correlation between mathematical determination scores and general scores of in-class, proficiency, understanding, nature of mathematics and mathematics attitude scale, and a moderate statistically significant relationship between problem solving scores (Respectively, r:0.16 r:0.15 r: 0.29 r:0.25 r:0.33 r:0.41; $p<0.05$).

It is seen that there is a positive and moderately statistically significant relationship between the general scores of mathematical metacognition awareness and in-class, proficiency, comprehension, problem solving, nature of mathematics and mathematics attitude scale (respectively, r: 0,37 r: 0,32 r: 0.34 r:0.51 r:0.38 r:0.45; $p<0.05$).

4. Discussion and Conclusion

In this study, the aim of which is to examine the relationship between middle school students' metacognitive awareness and their attitudes towards mathematics, the metacognitive awareness levels of middle school students and their attitudes towards mathematics were also compared according to gender. Comparisons of the sub-dimensions of both scales within and between scales were also examined. According to the research data, it has been observed that there is a moderately statistically significant positive correlation between the metacognitive awareness levels of middle school students and their attitudes toward mathematics. It can be said that as the metacognitive awareness of middle school students increases, their attitude scores toward mathematics also increase, that is, there is a positive relationship between metacognitive awareness and attitude towards mathematics. The high metacognitive awareness of students who develop positive attitudes toward mathematics has an important place in determining the relationship between these two variables. It is known that students who have positive attitudes toward lessons are aware of their learning processes and individuals who plan, monitor and evaluate these processes will be more successful (Schraw & Dennison, 1994). These results obtained from the study show parallelism with studies that revealed a positive relationship between middle school students and teacher candidates' attitudes toward mathematics and their metacognitive awareness (Sarpkaya et al., 2011; Kandal & Baş, 2021; Ajisuksmo et al., 2017; Maqsud, 1998).

Another finding obtained in the study is that there is no significant difference in the metacognitive awareness levels of middle school students according to gender. In other words, there is no difference between the metacognitive awareness of male and female students. In addition, it was determined that the answers given for the sub-dimensions of the metacognitive awareness scale did not differ according to the gender variable. These results show parallelism with the results found in studies examining the metacognitive awareness of middle school students and their attitudes toward mathematics (Kacar & Sarıçam, 2015; Sevgi & Çağlıköse, 2020; Ataalkın, 2012; Kandal & Baş, 2021; Memnun & Akkaya, 2009). In addition, it was determined that the sub-dimensions of the scale of attitude towards mathematics: in-class, proficiency, understanding, nature of mathematics, and general mathematics attitude did not show a statistically significant difference according to the gender of the individuals, but in the problem-solving sub-dimension scores, female students had higher scores

than boys. Although this situation shows parallelism with studies in which female students have higher scores in problem-solving attitude, it does not coincide with studies in which there is no significant difference between female and male students (İlhan, Gemcioğlu, & Poçan, 2021; Özgen, Ay, Kılıç, Özsoy, & Alpay, 2017).

Another result obtained from the study is that there is a positive, moderately statistically significant relationship between the sub-dimensions of the metacognitive awareness scale and the sub-dimensions of the attitude towards mathematics scale.

5. Suggestions

As a result, it can be said that it is necessary to pay attention to the positive relationship between these two variables, considering that students' metacognitive awareness and their attitudes toward mathematics affect each other. This study was carried out based on a quantitative approach with a total of 350 students studying in the fifth, sixth, seventh, and eighth grades of a public middle school in Turkey. This study can be repeated with different research approaches, different data collection, and different research groups. In particular, studies can be designed with a variety of qualitative research techniques that delve deeper into students' perceptions of the relationships among their psychological constructs. In this study, it was determined that students' attitudes toward mathematics were related to their metacognitive awareness. Other variables that may be related to attitude towards mathematics and metacognitive awareness can also be investigated. Considering that attitude towards mathematics and metacognitive awareness are one of the important indicators of students' mathematics achievement (Öztürk & Şahin, 2015; Toraman, Orakçı & Aktan, 2020), it is thought that the results obtained from these studies will contribute to the literature and increase students' success in mathematics courses.

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