Journal of Educational Studies in Science and Mathematics (JESSM) 2023
Volume 2 (1) Page 1 - 14
https://doi.org/10.29329/jessm.2023.618.1

Middle School Students' Metacognitive Attitude in Problem Solving, Metacognition, and Mathematical Literacy Self-Efficacy

Sevim Sevgi [1,*] & Ayşegül Nisa Alpaslan [2]

Abstract

This study examined the metacognitive attitudes in problem-solving, metacognition, and mathematical literacy self-efficacy of middle school students. A survey model, one of the descriptive research methods of the quantitative method, was used in the research. The research was conducted with 374 middle school students studying in three middle schools in the Southeastern Anatolia region. The "Metacognitive Attitude Scale in Problem Solving", the "Metacognition Scale", and the "Mathematical Literacy Self-Efficacy Scale" were used as data collection tools in the research. The results showed no statistically significant mean difference in the metacognitive attitudes in problem-solving, metacognition, and mathematical literacy self-efficacy between boys and girls or among different grade levels. The research provides valuable insights into the metacognitive abilities and attitudes of middle school students, which can inform future educational strategies and interventions.

Keywords: Metacognitive Attitude, Metacognition, Mathematical Literacy, Middle School

Received: 08.07.2023 – **Accepted:** 11.12.2023 – **Published:** 15.12.2023

[1] **Sevim Sevgi,** Assoc. Prof. Dr., Department of Mathematics Education, Erciyes University, Kayseri, Türkiye. ORCID: 0000-0003-3045-8832

[*] **Correspondence:** sevimsevgi@erciyes.edu.tr

[2] **Ayşegül Nisa Alpaslan,** Expert, Department of Mathematics Education, Erciyes University, Kayseri, Türkiye. ORCID: 0000-0002-6611-5543

INTRODUCTION

One of the important institutions in mathematics education, the National Council of Mathematics Teachers (NCTM) (1989), states that problem-solving is one of the most fundamental skills of mathematics education. According to Altun (2006), problem-solving enhances an individual's reasoning, discussion, and comparison skills. Many mathematical subjects and concepts can be conveyed to students through problem-solving, a teaching method applicable not only in mathematics but also in other courses (Aşık, 2015). While solving non-routine problems, students need to use their mathematical knowledge functionally, not by rote, so problem-solving skills develop as students encounter non-routine problems (Olkun et al., 2009).

Mathematical process skills represent a whole consisting of significant parts for the individual. These process skills are interconnected and supportive. According to NCTM (1989), problem-solving is one of the most fundamental skills of mathematics education. Metacognition, which includes mathematical representation, planning, control, awareness, strategy use, and conclusion, is a part of problem-solving skills (Çetinkaya & Erktin, 2002). Metacognition refers to the individual's regulation of their own mental thinking processes and their awareness of this process (Flavell, 1976). The ability of students to manage their own learning processes adequately and to develop their metacognitive knowledge and skills is among the specific objectives of our mathematics education program (MoNE, 2018).

To develop the metacognitive skills of individuals, appropriate learning environments are needed, along with the ability to structure their learning and develop their knowledge and skills (NCTM, 2000). Negative reactions and complaints about the difficulty of a mathematical problem are not just emotional responses from students with low success in mathematics. Rather, they are an indication of low metacognitive skills rather than a lack of knowledge (Aşık, 2015).

The primary purpose of studying mathematics is to cultivate a mathematical mindset in individuals. To achieve this goal, it is important to develop basic knowledge about the subject, problem-solving skills, metacognitive skills, self-confidence, and positive attitude (Altun, 2006). According to Pape et al. (2003), students who have well-developed problem-solving skills at the middle school level are more successful in regulating their mental processes than those with less developed skills.

Developing mathematical literacy skills and using them effectively are among the specific goals of Turkey's National Mathematics Education Program (MoNE, 2018). Mathematical literacy aims to make mathematics accessible to everyone and make sense of it (McCrone & Dossey, 2007).

Understanding, developing, connecting, and expressing the information given within the scope of mathematics education occurs within the problem-solving processes. Therefore, problem-

solving is an essential element of mathematical processes. Problem-solving is one of the most studied topics in literature. Akay et al. (2006) defined the concept of a problem, generally used and accepted, as an individual's immediate decision to overcome a complex problem or situation and think about it.

In literature, mathematical problem-solving is a subject that has been studied and continues to be actively studied by many researchers, such as Polya (1973) and Schoenfeld (1992). There are classifications of problems in the literature, such as verbal problem-algebraic problems, routine and non-routine problems (Selden et al., 1999), real-life problems (Freudenthal, 1991; Gravemeijer, 1997), and problem situations, open-ended and closed-ended problems.

The specific goals of the mathematics curriculum include actively using metacognitive skills and regulating one's own learning processes (MoNE, 2018). Aşık (2006) found a significant relationship between metacognitive and motivational and problem-solving skills. He also found that metacognitive experiences directly contribute to problem-solving skills. Aşık (2015) aimed to develop a support program to increase students' metacognitive skills to increase their success in solving verbal logic problems. In his mixed-pattern study, which involved 45 students, he obtained explanatory results about the metacognition-oriented support program and the form of the studies that developed it. He emphasized that supporting the metacognitive skills of students with studies carried out in learning environments will contribute to their development.

Mathematical literacy is the combination of knowledge and competencies required to meet mathematical needs in personal and social life (Geiger et al., 2015). Altun et al. (2018) examined the mathematics literacy levels of eighth-grade students through PISA questions. Middle school students have difficulties with associative and reflective thinking. In light of contextual problems in middle school mathematics, they predicted that these difficulties can be overcome if the students can express themselves through various methods. Bolstad (2021) stated that the mathematical contexts encountered by students in daily life and special mathematics topics affect their mathematical literacy skills. Therefore, presenting mathematical information connected to daily life at school will contribute to the development of students' mathematical literacy skills.

Significance and Purpose of Research

The education systems applied today are in a state of continuous development and change, in parallel with the needs of the age. To adapt this development in the Turkish Education System, change and development studies are carried out in the curriculum and teaching methods used. In mathematics education, the targeted level is for students to develop problem-solving and mathematical literacy skills. Based on this idea, it is of great importance to develop problem-solving and mathematical literacy skills.

Assumptions and Scope

There are some assumptions and limitations regarding the planning and implementation stages of this research. Knowing these is important for understanding the interpretations and inferences to be made about the research. The statements of the research are as follows:

• The data collection sources adequately serve the purpose of this study.

• The answers provided in response to the data collection tools are accurate and sincere.

• It is assumed that the methods and questions used in this research are appropriate for the research purpose.

Scope of this research:

• The study group of this research is limited to middle school students studying in three middle schools in the Southeastern Anatolia region during the 2022-2023 academic year.

• The study has a time limit of two teaching semesters.

• The pre-learning of the students to be included in the study could not be determined.

METHODOLOGY

The appropriate stages of the research method are presented. These include explanations about the research model, study group, data collection tools, and data analysis. In this study, the survey method, one of the descriptive research methods, was used. Karasar (2012) described the survey method as a research model that aims to determine the common variations between two or more variables. Statistical analyses of the data obtained from the research were conducted using a statistical package program. An attempt was made to present a general perspective.

Population and Sample

Convenience sampling was used in the research. In this method, the researcher prefers situations that are close and easy to access (Yıldırım & Şimşek, 2018). Since this sampling method is less expensive, practical, and easy, it is widely used in qualitative research (Yıldırım & Şimşek, 2018).

The sample consisted of 374 middle school students studying in three public schools in the İdil district of Şırnak province in the Southeastern Anatolia Region of Turkey. Care was taken in the selection of schools to choose those that included students with different levels of mathematical achievement. The aim was to provide maximum diversity in the participant groups by using convenient sampling among the purposive sampling methods.

Data Collection Tools

Data collection tools consist of two parts: quantitative and qualitative. In the first stage, the Demographic Information Form, Metacognitive Attitude Scale in Problem-Solving, Metacognition Scale, and Mathematical Literacy Self-Efficacy Scale were used to get to know students.

Demographic Information Form

It was applied to the students along with other scales to get to know their age, gender, branch, grade level, number of siblings, monthly income of the family, father's education level, mother's education level, whether they have their own room, internet connection, and tablet. This is a form for recognizing students with questions, which was prepared by the researcher.

Metacognitive Attitude Scale in Problem Solving

This scale aims to determine the metacognitive attitudes of students in problem-solving. The scale was developed by Aşık (2015). It contains 29 items, with 14 positive items and 15 negative items. The scale is a four-point Likert type with the options of Strongly Disagree, Disagree, Agree, and Strongly Agree. It consists of four dimensions: problem orientation, operation, process monitoring, and result control. The distribution of the items in the scale according to their dimensions is given in Table 1.

Table 1

Distribution of the Items in the Metacognitive Attitude Scale in Problem Solving by Dimensions

Dimensions	Items
Problem orientation (11 items)	1, 4, 5, 10, 11, 15, 17, 24, 25, 26, 27
Processing stage (10 items)	2, 3, 6, 7, 12, 14, 21, 22, 23, 28
Process control (5 items)	9, 16, 18, 19, 20
Results check (3 items)	8, 13, 29

In the studies conducted to assess the scale's reliability, the Cronbach alpha internal consistency coefficient was calculated to be 0.7, an accepted value. Content validity of the scale was provided through expert opinion and literature review (Aşık, 2015). Factor analysis was performed for the scale's construct validity, and construct validity was ensured by grouping the scale items into four dimensions by Aşık (2015).

Metacognition Scale

The Metacognition Scale aims to measure students' metacognitive awareness and abilities. It was developed by Yıldız et al. (2009). The scale consists of 30 items in a 4-point Likert type with the

options of Never, Sometimes, Often, and Always. The scale items were grouped into four factors by Yıldız et al. (2009) according to factor analysis results.

The Cronbach's alpha internal consistency coefficient of the scale was calculated as 0.96. The factor analysis performed to examine the construct validity of the scale revealed that it consisted of eight sub-dimensions: declarative knowledge, procedural knowledge, conditional knowledge, planning, monitoring, control, cognitive strategies, and evaluation. The lowest possible score on this scale is 30, and the highest possible score is 120 (Yıldız et al., 2009). It takes approximately 15-20 minutes to complete the scale.

Mathematical Literacy Self-Efficacy Scale

The aim is to determine the levels of students' self-efficacy in mathematical literacy. The scale was developed by Baypınar and Tarım (2019). The scale comprises 30 5-point Likert-type items with response options ranging from "Totally Agree" to "Strongly Disagree". Following the factor analysis, the scale items were grouped into four factors.

For the content validity of the scale, the opinions of three experts and three language experts were consulted. In studies conducted for reliability, the internal consistency coefficient (Cronbach's alpha) was calculated as 0.925 indicating that the scale is highly reliable. When considering the coefficients calculated for the sub-dimensions of the scale, it was observed that the 1st and 3rd factors had high reliability, while the 2nd and 4th factors had good reliability.

Analysis of Data

The descriptive statistical values of the data obtained from the scales were examined. Normality analyses were performed using Kolmogorov-Smirnov and Shapiro-Wilk tests to determine whether the data were normally distributed. Descriptive statistical values were examined according to gender and grade levels, and normality analyses were performed using the Kolmogorov-Smirnov test to determine whether the data were normally distributed. Then, Levene's test was applied to determine the homogeneity of the groups. Independent sample *t*-test and One-way ANOVA test were performed to determine whether there was a significant mean difference between the groups according to gender and grade level.

FINDINGS

The findings section exlores whether the metacognitive attitudes in problem solving, metacognition, and mathematical literacy self-efficacy of middle school students vary significantly

based on gender and grade level. The quantitative portion of the study involved a total of 374 middle school students. The descriptive statistics are given in Table 2.

Table 2

Descriptive Statistics of Students

Variable		N	%
Gender	Girl	210	56.1
	Boy	164	43.9
Grade Level	5th grade	62	16.6
	6th grade	114	30.5
	7th grade	120	32.1
	8th grade	78	20.9
Age	10 years old	28	7.5
	11 years old	94	25.1
	12 years old	115	30.7
	13 years old	116	31
	14 years old	21	5.6
Number of siblings	1-3	50	13.4
	4-6	180	48.1
	7-9	100	26.7
	9-11	27	7.2
	11 and more	17	4.5
Economic Income of the Family	Low	50	13.4
	Middle	168	44.9
	Good	123	32.9
	Very good	33	8.8
Father’s Education Level	No Literacy	30	8
	Primary school	94	25.1
	Middle school	110	29.4
	High school	96	25.7
	University	44	11.8
Mother’s Education Level	No Literacy	137	36.6
	Primary school	111	29.7
	Middle school	83	22.2
	High school	32	8.6
	University	11	2.9
Students' Own Room	Yes	145	38.8
	No	229	61.2
Internet Connection at Home	Yes	268	71.7
	No	106	28.3
Students' Own Tablet	Yes	110	29.4
	No	264	70.6

Out of 374 students, 210 are girls and 164 are boys. The highest attendance was recorded in the 7th grade with 120 students, while the 5th grade had the lowest with 62 students. In terms of age distribution, 231 students are aged between 12 and 13, and 28 students are 10 or older. There are 180 students with a sibling count between 4-6, and 17 individuals have 11 or more siblings. The economic income level of the most families is middle, with 168 students falling into this category. The education level of the fathers is predominantly middle school, with 110 students, while the mothers’ education level is higher, with 137 students. More than half of the students did not have their own rooms or tablets, but the vast majority have an internet connection at home (Table 2).

Descriptive Statistics for the Scales

The descriptive statistics of the scores obtained from the Metacognitive Attitude Scale in Problem-Solving, Metacognition Scale, and Mathematical Literacy Self-Efficacy Scales are presented in Table 3.

Table 3

Descriptive Statistics for the Scales

Scales		Statistics
Metacognitive Attitude	Mean	71.25
	Median	71
	Minimum	39
	Maximum	99
	Skewness	-.066
	Kurtosis	1.331
Metacognition	Mean	83.83
	Median	84
	Minimum	35
	Maximum	120
	Skewness	-.045
	Kurtosis	-.088
Mathematics Literacy	Mean	81.81
	Median	81
	Minimum	40
	Maximum	131
	Skewness	0.321
	Kurtosis	0.874

The highest score obtained from the Metacognitive Attitude in Problem-Solving Scale is 99 and the lowest is 39. The mean of the data obtained from the scale is 71.25, and the median is 71. The fact that the mean value and the median value are very close to each other shows that the data group has a normal distribution tendency. Kurtosis (1.331) and skewness (-0.066) values, which are among the values obtained, show normal distribution since they have values between +1.5 and -1.5 according to Tabachnick and Fidell (2013).

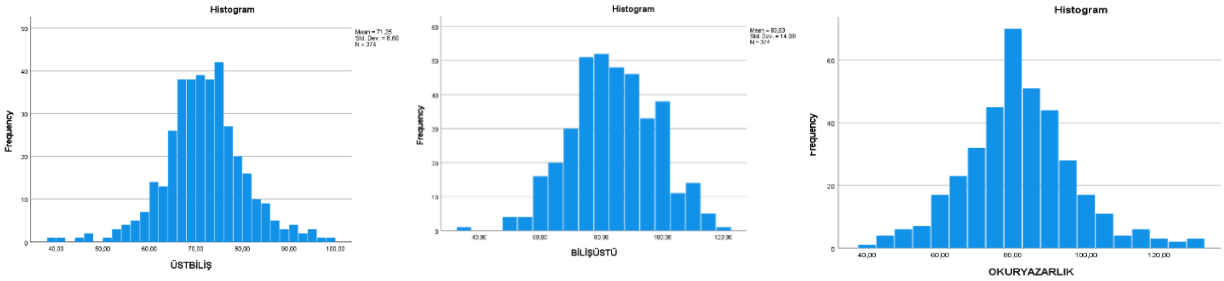
The highest score obtained from the Metacognition Scale is 120, and the lowest is 35. The mean of the data obtained from the scale is 83.83, and the median is 84. The fact that the mean value and the median value are very close to each other shows that the data group tends to normal distribution. The values of kurtosis (-0.088) and skewness (-0.045), which are among the required values, indicate a normal distribution since they have values between +1.5 and -1.5 according to Tabachnick and Fidell (2013).

The highest score obtained from the Mathematical Literacy Self-Efficacy Scale is 131, and the lowest is 40. The mean of the data obtained from the scale is 81.81, and the median is 81. The fact that the mean value and the median value are very close to each other shows that the data group has a normal distribution tendency. The kurtosis (0.874) and skewness (0.321) values, which are among the values obtained, indicate a normal distribution since they have values between +1.5 and -1.5

according to Tabachnick and Fidell (2013). The normal distribution graphs of the data obtained from the scales are shown in Figure 1.

Figure 1

Histograms of Normal Distribution Scales



Metacognitive Attitude | Metacognition | Literacy

Analysis of the Metacognitive Attitude Scale in Problem-Solving, Metacognition Scale, and Mathematical Literacy Self-Efficacy Scales by Gender

The scores obtained from the Metacognitive Attitude Scale in Problem-Solving, Metacognition Scale, and Mathematical Literacy Self-Efficacy Scales were analyzed by gender.

In the Metacognitive Attitude Scale in Problem-Solving, the highest score for girls is 96 and the lowest is 39, while for boys, the highest score is 99 and the lowest is 44. The mean of the data obtained from the scale is 71.04, the median is 71. The mean for boys is 71.5, and the median is 71.5. The fact that the mean and median values are very close to each other shows that the data group tends to normal distribution.

From the Metacognition Scale, the highest score for girls is 120, the lowest is 48. For boys, the highest score is 113, and the lowest is 35. The mean score obtained from the scale is 84.80, with a median of 84 for girls and 82.59 with a median of 83.5 for boys. The fact that the mean and median values are very close to each other indicates a normal distribution tendency in the data.

From the Mathematical Literacy Self-Efficacy Scale, the highest score for girls is 130, the lowest is 45. For boys, the highest score is 131, and the lowest is 40. The mean of the data obtained from the scale is 81.86, and the median is 83. The mean for boys is 81.74, and the median is 80.5. The fact that the mean and median values are very close to each other shows that the data group has a normal distribution tendency.

An independent samples *t*-test was conducted to determine if there was a significant difference in the mean scores of boys and girls regarding their metacognitive attitudes in problem-solving, metacognition, and mathematical literacy self-efficacy.

The Levene test performed to assess the equality of variances, the related results is given in Table 4, for the scores obtained from the metacognitive attitude scale in problem-solving, F(372)= 0.178; considering the significance compared to p=0.673], the assumption of equality of variances is provided since it provides a value of p>0.05. For the scores obtained from the metacognition scale, [F (372) = 0.840; p=0.36], the assumption of equality of variances is provided since it provides a value of p > 0.05. For the scores obtained from the middle school mathematical literacy self-efficacy scale (F (372) = 1.425; p=0.233>0.05), the assumption of equality of variances is provided. As a result of these results, the variances of the groups are equal.

Table 4

Levene Test Results

Scale	F	p	t	df	p
Metacognitive attitude	0.178	0.673	-0.518	372	0.605
Metacognition	0.840	0.360	1.516	372	0.13
Literacy	1.425	0.233	0.076	372	0.94

An independent samples *t*-test was utilized if there was a statistically significant mean difference in metacognitive attitudes in problem-solving, metacognition, and mathematical literacy self-efficacy between boys and girls.

Table 5

Independent Samples t-test Results by Gender

Indepedent variable	Gender	N	Mean	Standard Deviation	df	t	*p*
Metacognitive attitude	Boy	210	71.0476	8.74780	372	-0.518	0.605
	Girl	164	71.5122	8.43924	355.888	-0.520	0.603
Metacognition	Boy	210	84.8048	14.30478	372	1.516	0.130
	Girl	164	82.5915	13.63090	35.635	1.525	0.128
Mathematical literacy	Boy	210	81.8619	15.49857	372	0.076	0.940
	Girl	164	81.7439	14.13025	363.158	0.077	0.939

Independent samples of the *t*-test results indicate that there was no statistically significant mean difference in metacognitive attitudes in problem-solving, metacognition, and mathematical literacy self-efficacy between boys and girls (p>0.05).

Analysis of the Metacognitive Attitude Scale in Problem Solving, Metacognition Scale, and Mathematical Literacy Self-Efficacy Scales by Grade Levels

The descriptive statistics obtained from the Problem-Solving Metacognitive Attitude Scale, Metacognition Scale, and Middle School Mathematical Literacy Self-Efficacy Scales according to grade levels, are given in Table 6.

Table 6

Descriptive Statistics of Scales by Grade Level

Scale	Grade	N	Mean	Min	Max
Metacognitive Attitude	5	62	70.59	39	94
	6	114	70.92	52	94
	7	120	70.81	41	99
	8	78	72.92	55	93
Metacognition	5	62	88.14	52	120
	6	114	83.63	55	117
	7	120	83.07	35	112
	8	78	81.87	48	115
Literacy	5	62	78.27	46	124
	6	114	83.48	46	130
	7	120	81.65	40	115
	8	78	82.42	45	131

Nonsignificant Levene's Test results showed that the homogeneity of variances assumption was met across the scales: for metacognitive attitude, F (3, 370) = 1.704, and p=0.166, for metacognition, F (3, 370) = 1.056, and p=0.368, for literacy, F (3, 370) = 0.418, and p=0.74, indicating homogeneity.

A one-way ANOVA was used to determine if there was a statistically mean difference in the mean grades of students based on their metacognitive attitudes in problem-solving, metacognition, and mathematical literacy self-efficacy. The ANOVA results based on grade level is presented in Table 7.

Table 7

ANOVA Results by Grade Level

Scale		Sum of Squares	df	Mean of Squares	F	p
Metacognitive Attitude	Between groups	279.66	3	93.20		
	Within group	27342.71	370	73.89	1.26	.287
	Total	27622.37	373			
Metacognition	Between groups	1526.45	3	508.82		
	Within group	71977.26	370	194.53	2.616	.051
	Total	73503.72	373			
Literacy	Between groups	1126.37	3	375.46		
	Within group	81623.14	370	220.60	1.702	.166
	Total	82749.52	373			

Table 7 presents the ANOVA results, which indicate that there was no statistically significant mean difference in the metacognitive attitudes in problem-solving, metacognition, and mathematical literacy self-efficacy among students of different grade levels.

CONCLUSION

In conclusion, this study thoroughly examined the metacognitive attitudes in problem-solving, metacognition, and mathematical literacy self-efficacy among middle school students using various scales and descriptive research methods. The results indicated that there was no significant mean

difference in these aspects between boys and girls, or among students of different grade levels. These findings suggest that factors such as gender and grade level may not significantly impact a student's metacognitive attitudes, metacognition, and mathematical literacy self-efficacy. However, future research could explore other potential factors that may influence these aspects. The study contributes valuable insights to the understanding of metacognition and problem-solving among middle school students, which can be beneficial for educators in developing teaching strategies that support students' cognitive development.

RECOMMENDATIONS

- Based on the findings of this study, the following recommendations can be made:
- Focus on Gender Differences: Although the research found no significant mean differences in metacognitive attitudes, metacognition, and mathematical literacy self-efficacy between boys and girls, it may be beneficial to further investigate this area, considering the differences in learning styles and preferences between genders.
- Grade Level Analysis: The study did not find significant mean differences among students of different grade levels in their metacognitive attitudes, metacognition, and mathematical literacy self-efficacy. However, further research could be done to consider other factors, such as curriculum differences or teaching methods across different grade levels.
- Metacognitive Training: Since metacognition plays a crucial role in problem-solving and learning, educators should consider implementing metacognitive training in their teaching methods. This could potentially enhance students' problem-solving abilities and improve their self-efficacy in mathematical literacy.
- Economic Status and Parental Education: The manuscript provided descriptive statistics on students' economic status and parents' education level. However, it did not delve into how these factors may influence metacognitive attitudes, metacognition, or mathematical literacy self-efficacy. Future research could explore these potential correlations.
- Utilize Technology: A large number of students reported having internet access at home. Educators and school administrators could leverage this to provide additional learning resources and tools that could further enhance students' metacognition and mathematical literacy skills.

REFERENCES

Akay, H., Soybaş, D., and Argün, Z. (2006). Problem posing experiences and using open-ended questions in mathematics teaching. *Kastamonu Eğitim Dergisi, 14*(1), 129-146.

Altun, M. (2006). Matematik öğretiminde gelişmeler. *Uludağ Üniversitesi Eğitim Fakültesi Dergisi, 19*(2), 223-238.

Altun, M., Gümüş, N. A., Akkaya, R., Bozkurt, I., and Ülger, T. K. (2018). Investigation of mathematics literacy skill levels of eighth grade students. *Journal of Science, Mathematics, Entrepreneurship and Technology Education, 1*(1), *66-88.*

Aşık, G. (2015). *A design study on metacognitive training in problem solving* [Unpublished doctoral dissertation]. Marmara University.

Baypınar, K., and Tarım, K. (2019). The development of mathematical literacy self-efficacy scale for middle school: A reliability and validity study. *Cukurova University Faculty of Education Journal, 48*(1), 878-909. https://doi.org/10.14812/cuefd.415291

Bolstad, O. H. (2021). Lower secondary students' encounters with mathematical literacy. *Mathematics Education Research Journal, 35,* 237–253. https://doi.org/10.1007/s13394-021-00386-7

Borromeo Ferri, R. (2007). Personal experiences and extra-mathematical knowledge as an influence factor on modelling routes of pupils. In D. Pitta-Pantazi & C. Philippou (Eds.), *European Research in Mathematics Education V: Proceedings of the Fifth Congress of the European Society for Research in Mathematics Education* (pp. 2080–2089). University of Cyprus.

Çetinkaya, P., and Erktin, E. (2002). Assessment of metacognition and its relationship with reading comprehension, achievement, and aptitude. *Boğaziçi Üniversitesi Eğitim Dergisi, 19*(1), 1-11.

Ferri, R. B. (2007). Personal experiences and extra-mathematical knowledge as an influence factor on modelling routes of pupils. Proceedings of CERME-5, WG 13 Modelling and Applications, 2080-2089.

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry. *American Psychologist, 34*(10), 906–911. https://doi.org/10.1037/0003-066X.34.10.906

Fraenkel, J. R., and Wallen, N. E. (2006). *How to design and evaluate research in education.* (6th ed.). New York: McGraw-Hill International Edition.

Freudenthal, H. (1991). *Revisiting mathematics education*. Dordrecht: Kluwer.

Geiger, V., Goos, M., and Forgasz, H. (2015). A rich interpretation of numeracy for the 21st century: a survey of the state of the field. *ZDM Mathematics Education, 47*(4), 531–548. https://doi.org/10.1007/ s11858-015-0708-1

Gravemeijer, K. (1997). Solving word problems: A case of modelling?. *Learning and Instruction, 7*(4), 389-397.

Ministery of National Education (MoNE) (2018). *Matematik dersi (1, 2, 3, 4, 5, 6, 7 ve 8. sınıflar) öğretim programı*. Ankara. Millî Eğitim Basımevi.

NCTM. (1989). *Curriculum and evaluation standards for school mathematics*. Reston, VA: NCTM Publications.

NCTM (2000). *Principals and standards for school mathematics*. Reston, VA: National Council of Teachers of Mathematics Publications.

Olkun, S., Sahin, Ö., Akkurt, Z., Dikkartin, F. T., and Gülbagci, H. (2009). Problem solving and generalization through modeling: A study on elementary school students. *Education and Science, 34*(151), 65.

Pape, Stephen J., and Wang, C. (2003). Middle school children's strategic behavior: Classification and relation to academic achievement and mathematical problem solving. *Instructional Science, 31*, 419–449

Pesen, C. (2008). *Yapılandırmacı öğrenme yaklaşımına göre matematik öğretimi*. Ankara: Pegem A Yayıncılık.

Schoenfeld, A. (1992). Learning to think mathematically: Problem solving, metacognition, and sense making in mathematics. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 334–370). Macmillan: New York.

Schukajlow, S., Krug, A., and Rakoczy, K. (2015). Effects of prompting multiple solutions for modelling problems on students' performance. *Educational Studies in Mathematics, 89*(3), 393-417. https://doi.org/10.1007/s10649-015- 9608-0

Selden, A., Selden, J., Hauk, S., and Mason, A. (1999). Do calculus students eventually learn to solve non-routine problems? Retrieved from http://www.math.tntech.edu/techreports/TR_1999_5.pdf

Tabachnick, B. G., and Fidell, L. S. (2013). *Using multivariate statistics* (6th ed.) Pearson, Boston.

Yıldırım, A., and Şimşek, H. (2018). *Sosyal bilimlerde nitel araştırma yöntemleri*. Ankara: Seçkin Yayıncılık.

Yildiz, E., Akpinar, E., Tatar, N., and Ergin, O. (2009). Exploratory and confirmatory factor analysis of the metacognition scale for primary school students. *Educational Sciences: Theory and Practice, 9*(3), 1591-1604.