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Abstract

This study examines the relationship between secondary school students' reflective thinking skills toward problem solving and their metacognitive awareness. Using the correlational survey method, this study selected a sample of 571 secondary school students from Afyonkarahisar province during the 2022-2023 academic year using the convenient sampling method. The study used the 'Reflective Thinking Skills Scale for Problem Solving' and the 'Metacognitive Awareness Scale for Children' as data collection tools. Descriptive statistics, correlation analysis, and simple linear regression analysis were used to analyze the collected data. According to the findings of the study, secondary school students' reflective thinking skills for problem solving and their metacognitive awareness are positively and highly related. Furthermore, the study determined that the reflective thinking skills of secondary school students for problem solving significantly predict their metacognitive awareness.

Introduction

The evolving structure of today's world impacts education and its central character, the individual, in diverse ways. These changes shape society's expectations of individuals and lead to the differentiation of their needs. The 21st century expects individuals to possess critical, creative, and reflective thinking skills, concentrate on problem solving, understand what and how to learn, and adapt to various situations and events (World Economic Forum, 2021). Education reforms aim to realize these expectations by ensuring the development of both the individual and society. As a result, individuals who can develop and change themselves will pave the way for the change and transformation of society.

The most fundamental difference that distinguishes human beings from other living things is that they have the ability to think. What gives meaning to the existence of the individual is the effective use of his/her thinking skills and his/her participation in social life in a way that will benefit social life. Thinking is an active, goal-oriented, systematic mental process that individuals carry out in order to understand the events they encounter and the situation they are in (Demirel, 2005). The process of thinking, which involves transforming information into

concepts and analyzing and interpreting it, can manifest in various forms, including creative, reflective, critical, analytical, inductive, or deductive thinking (Duman, 2018; Saban, 2005). In addition to facilitating individuals' participation in democratic life, it is clear that these different types of thinking skills will significantly contribute to individuals' psychological development and help them have the necessary competence to adapt to the processes in the fields of school, work, and technology (Epstein & Kernberger, 2006). Thus, it will be possible for individuals with increased chances of success to have a quality and productive life.

The most important feature that distinguishes different types of thinking from ordinary thinking is that the individual is mentally active, aware, and decisive during the thinking phase. Reflective thinking skills, one of these special types of thinking, enable individuals to control their own learning, question, perceive, and evaluate what they have learned with their own reasons (Schaaf et al., 2013). Reflective thinking is defined as creating new thoughts and information based on previous knowledge or thoughts, analyzing past experiences, and acquiring new ones (Mezirow, 1991). Reflective thinking is a process that enables an individual to increase his/her learning experiences rather than learning by memorizing the stereotyped information presented to him/her (Schön, 1987). Therefore, reflective thinking plays a great role in the cognitive development of individuals.

Boyd and Fales (1983) define reflective thinking as an internal inquiry process that pertains to a problem. On the other hand, Bingham (2004) explains problem solving as a series of mental processes where individuals apply their knowledge and skills to solve the problem. In this direction, the emergence of reflective thinking skills requires the individual to be in a process in which they strive to overcome a problem (Kızılkaya & Aşkar, 2009; Ülker, 2019; Ünver, 2003). In the problem solving process, as in reflective thinking, strategies for solutions are developed, what, why, and how are investigated, and the most appropriate way is chosen by considering the desired result (Güney, 2008; Kızılkaya & Aşkar, 2009). Thus, reflective thinking helps the individual in problem solving and decision-making stages.

Conceptual Framework

According to the literature on thinking skills, reflective thinking and problem solving are considered metacognitive activities (Daudelin, 1996). Reflective thinking skill for problem solving (RTSPS) is a concept that brings these two metacognitive skills together. With the reflective thinking skill for problem solving, the individual can adapt the actions he/she performs in problem solving steps to new situations by being aware of why he/she does them, can determine alternative solutions, can benefit from his/her experiences in the solution process, and, in short, can realize meaningful learning (Kızılkaya & Aşkar, 2009).

Thinking and cognition are closely related concepts. Cognition is the totality of mental processes, including knowledge, perception, understanding, and remembering, required to solve a problem or complete a task. On the other hand, metacognition refers to the knowledge required to comprehend and learn how to solve a problem or perform a task (Schraw, 2001). In general, metacognition includes how to reflect on one's own thoughts, how to predict the proper way of problem solving, and how to draw conclusions from solutions. Metacognition, which includes knowing how to transform what is learned into practice and transfer it to life, can be briefly expressed as

the act of thinking about thinking (Babacan, 2012). In metacognition, planning, monitoring, organizing, and controlling the cognitive processes of the individual enables the individual to gain experience and realize how he/she thinks and learns (Duman, 2013). At this point, the concept of metacognitive awareness emerges. Metacognitive awareness refers to individuals' awareness of themselves, their behaviors, and problem-solving strategies through their conscious cognitive experiences (Flavell, 1979; Schraw & Dennison, 1994). In this way, the individual learns to learn and achieves success by transforming his/her own learning into practice.

Metacognitive awareness consists of self-awareness, knowledge awareness, task awareness, and strategy awareness (Graham, 1994). Therefore, individuals who possess metacognitive awareness also need to engage in reflective thinking. Similarly, problem-solving processes effectively employ reflective thinking. Reflective thinking, which provides communication between theory and practice, supports the mental processes of the individual and enables him/her to solve all kinds of problems with effective, decisive, and efficient methods (Gelter, 2003). In this context, determining the levels of reflective thinking skills and metacognitive awareness for problem solving and the relationship between them will be a guide to ensure that students' learning is more efficient and of higher quality.

Concepts of reflective thinking and metacognitive awareness for problem-solving will initiate changes in learning that will benefit society, the country's development, and humanity, beginning with the individual's personal life. In this context, the research emphasizes the importance of working with students in the secondary school process, as it represents a significant turning point in the educational journey of individuals. Given that our country mandates primary education for students aged 6-14, secondary school students typically range in age from 10-14. When this age group is examined, it is seen that it consists of children who have acquired literacy skills, can perform basic mathematical operations, have started to move from concrete thinking to abstract thinking, care about academic success, and are in the process of becoming pre-adolescent individuals (Doğan, 2007). In this period, children begin to develop characteristics such as logical and abstract thinking, making assumptions, solving complex problems systematically, and cooperating (Gander & Gardiner, 2001). This period is also a time when children gain the ability to work, learn, and research on their own, develop the ability to solve the problems they encounter with their own personal initiatives, and form their thoughts about the future (Yavuzer, 1984). From this point of view, it is extremely important to determine the levels of problem solving, reflective thinking, and metacognitive awareness skills of secondary school students, which will affect their entire lives, their relationships with each other, and their differences due to various variables.

One can say that mathematics is a field of science that emerged from the desire to solve the problems encountered by human beings, with problem solving being one of its main areas. Problem solving constitutes the most important step of mathematical processes, which are defined as problem solving, association, communication, mathematical modeling, and reasoning (Walle et al., 2013). According to OECD (2023), mathematical processes explain what individuals do to relate the context of the problem to mathematics and solve it. Moreover, one of the sub-skills of mathematical literacy, considered a 21st-century skill, is problem solving. Since PISA 2012, in order to provide a more comprehensive perspective on individuals' 'readiness for life,' 'innovative domain' cycles have been defined with an interdisciplinary approach targeting 21st-century competencies (OECD, 2023). Examining

these cycles reveals that innovative areas, such as creative problem solving in PISA 2012, collaborative problem solving in PISA 2015, global competencies in PISA 2018, and creative thinking skills in PISA 2022, primarily focus on problem solving.

Furthermore, the MoNE (2018) mathematics education program aims to educate individuals in the context of evolving individual and social needs. This includes producing knowledge, applying it functionally in life, problem-solving, critical thinking, entrepreneurship, possessing communication skills, and contributing to society and culture. It is clear from all these explanations that today's people will require problem-solving skills in every field.

It is expected that the study's findings will shed light on the phenomenon of quality learning and generate various ideas for improving learning. Furthermore, the study's results will significantly contribute to the planning and structuring of educational studies related to curriculum, students, teachers, and educational environments, serving as a guiding principle for future academic research. In this context, the problem statement of the research was determined to be "What is the relationship between secondary school students' reflective thinking skills for problem solving and their metacognitive awareness?". In addition, some sub-problems were created in order to better clarify the problem stated in the problem statement. These are:

1. What is the distribution of secondary school students' reflective thinking skills and metacognitive awareness levels in relation to problem solving?
2. Does the relationship between secondary school students' reflective thinking skills and metacognitive awareness toward problem solving differ according to gender, class level, mother's education level, father's education level, and residence?
3. To what extent do secondary school students' reflective thinking skills for problem solving predict their metacognitive awareness?

Method

This research was conducted in the correlational survey model, one of the quantitative research methods. The correlational model is a research model that aims to determine the existence or degree of change between two or more variables (Fraenkel & Wallen, 2010). In this context, researchers systematically investigate events and phenomena by collecting quantitative data and analyzing it using mathematical and statistical techniques (Creswell, 2014). This study designed a correlational model to examine the relationship between secondary school students' reflective thinking skills toward problem solving and their metacognitive awareness in terms of various variables.

Study Group

The general population of this study consists of secondary school students studying in Afyonkarahisar province in the 2022-2023 academic year. The sample of the study was determined by the convenient sampling method. In the convenience sampling method, the researcher creates his/her sample based on the most accessible respondents

until he/she reaches a group of the size he/she needs (Creswell, 2014). Accordingly, the data collected from 567 secondary school students were subjected to analysis. The distribution of the sample selected to collect the research data in terms of the variables to be evaluated in the analysis is given in Table 1.

Table 1. Sample Distribution

Variable	Subgroup	f	%
Gender	Female	291	51.3
	Male	276	48.7
Class Level	5th grade	142	25.0
	6th grade	159	28.0
	7th grade	159	28.0
	8th grade	107	18.9
Mother's Education Level	Primary School	195	34.4
	Secondary School	203	35.8
	High School	108	19.0
	Undergraduate	61	10.8
Father's Education Level	Primary School	114	20.1
	Secondary School	181	31.9
	High School	140	24.7
	Undergraduate	132	23.3
Residential	Village/Town	286	50.4
	City Center	281	49.6
Total		567	100.0

Data Collection Tools

The "Reflective Thinking Skills Scale for Problem Solving" developed by Kızılkaya and Aşkar (2009) was used to measure secondary school students' reflective thinking skills for problem solving. The scale consists of 14 items, including three dimensions of reflective thinking: questioning, reasoning, and evaluation. A 5-point Likert scale grades the scale. The Cronbach's alpha coefficient calculated to determine the reliability of the scale was .57 for the questioning dimension, .63 for the reasoning dimension, .56 for the evaluation dimension, and .81 for the overall scale. These values indicate a high level of reliability for the scale.

In order to measure the metacognitive awareness of the students, the "Metacognitive Awareness Scale for Children" developed by Karakelle and Saraç (2007) was used. The metacognitive awareness scale developed by Sperling et al. (2002) to measure the metacognitive skills of 3rd-9th grade students was adapted into Turkish by Karakelle and Saraç (2007). It consists of A and B forms for different age groups. The scales, consisting of 12 items in form A and 18 items in form B, are one-dimensional. Since the participants of this study were secondary school students, Form B with 18 items was used. The scale is graded on a 5-point Likert-type scale. The reliability coefficient of the scale was calculated as 0.84. This value indicates that the scale exhibits high reliability.

Data Analysis

The statistical package program transferred the data collected from the application of the scales in the study to the computer environment for analysis. In order to determine which of the parametric or nonparametric methods to analyze the data collected from the study, a normality test was performed first, and it was checked whether the data were normally distributed. The control of normality for the scale total scores and all variables was found separately according to the skewness and kurtosis coefficients. Table 2 presents the calculated values for skewness and kurtosis.

Table 2. Skewness and Kurtosis Values for Variables

	Skewness	Kurtosis
RTSPS	-0.244	0.330
Reasoning	-0.209	0.021
Evaluation	-0.404	0.081
Reasoning	-0.248	-0.238
Metacognitive Awareness	-0.360	0.370

When the values in Table 2 are examined, it is seen that the skewness and kurtosis values are between -1.0 and +1.0. Tabachnick & Fidell (2014) consider kurtosis and skewness as normally distributed when their values fall between -1.5 and +1.5. Therefore, it was decided to use parametric tests in the study. While determining the reflective thinking skills and metacognitive awareness levels of secondary school students towards problem solving, the mean of their responses to the scale items was taken into consideration, and descriptive statistics such as frequency, mean, and standard deviation were used. Pearson Product Moment Correlation was used to analyze the existence of a relationship between the scales and whether this relationship differed significantly in terms of different variables. Correlation analysis classifies coefficient values between 0-0.30 as low correlation, 0.30-0.70 as medium correlation, and 0.70-1.00 as high correlation (Field, 2013). Simple linear regression analysis was used to examine the predictive status of secondary school students' reflective thinking skills towards problem solving and metacognitive awareness. In the interpretation of simple linear regression analysis, standardized Beta (β) coefficients and t-test results were taken into consideration.

Additionally, partial correlation analysis was conducted to examine the relationship between secondary school students' reflective thinking skills towards problem solving and their metacognitive awareness in terms of variables. In order to make the correlation coefficients comparable with each other, the correlation values were transformed into standardized z values, and this transformation was applied using Fisher's formula given below (Field, 2005 as cited in Can, 2020).

$$Z_r = \frac{1}{2}\log_e\left(\frac{1+r}{1-r}\right)$$

The difference between the standardized correlation coefficients was calculated using the following formula (Field, 2005 as cited in Can, 2020).

$$zdif. = \frac{\mathrm{zr1} - \mathrm{zr2}}{\sqrt{\frac{1}{N1-3} + \frac{1}{N2-3}}}$$

The formula accepts a significant difference between the standardized correlation coefficients if the result is 1.96 and above, and it rejects a significant difference if it is less than this value (Can, 2020). A significance level of .05 was used in all analyses conducted in the study.

Results

Table 3 presents the results of the analyses conducted to determine the reflective thinking tendency and metacognitive awareness levels of secondary school students towards problem solving.

Table 3. Descriptive Statistics on RTSPS and Metacognitive Awareness

Dimension	n	Min.	Max.	x̄	SD
RTSPS	567	14	70	47.04	9.448
Reasoning	567	5	25	16.50	3.724
Evaluation	567	5	25	17.25	3.902
Reasoning	567	4	20	13.24	3.405
Metacognitive Awareness	567	18	90	65.88	11.450

The results obtained from the scale in Table 3 show that secondary school students' reflective thinking skills for problem solving (x̄=3.36) are at the 'medium' level. When the items of the scale were examined, the items with the highest participation of secondary school students were determined as "After solving the problem and finding the result, I check the operations I do" (x̄=3.88), "When I read a problem, I think about what information I need for the solution" (x̄=3.73) and "When solving a problem, I think about why I do what I do" (x̄=3.66). In addition, it was determined that they showed the least participation in the item "When solving problems, I ask myself questions to find different solutions" (x̄=2.97).

Examining the scores from Table 3 reveals that the mean metacognitive awareness level of secondary school students (x = 3.66), a single-dimensional measure, falls into the 'most of the time' category. This situation indicates that the metacognitive awareness levels of secondary school students are high. When the items of the scale were examined, it was found that the items with the highest participation of the secondary school students were "I listen to important information very carefully" (x̄=4.24), "I know whether I understand something" (x̄=4.22) and "I learn the subjects that interest me better" (x̄=4.19). In addition, it was determined that they showed the least participation in the item "At the end of my study, I ask myself whether I have learned the subject I want to learn" (x̄=3.17).

Due to the normal distribution of the data, we used the Pearson Product Moment Correlation, one of the parametric tests, to examine whether there is a significant relationship between secondary school students' reflective thinking skills for problem solving and their metacognitive awareness levels. Table 4 presents the analysis's result.

Table 4. Correlation Analysis Results between RTSPS and Metacognitive Awareness

		Metacognitive Awareness
RTSPS	r	.726*
	p	.00
	n	567

*p < .01

As a result of the analysis, a significant and highly positive relationship was found between secondary school students' reflective thinking skills for problem solving and their metacognitive awareness levels ($r = .726$, $p < .01$). Table 5 presents the results of a Pearson correlation analysis between the reflective thinking skills of secondary school students for problem solving and their levels of metacognitive awareness in relation to the gender variable.

Table 5. Correlation Analysis Results between RTSPS and Metacognitive Awareness in Gender Groups

Gender			Metacognitive Awareness
Female	RTSPS	r	.701*
		p	.00
		n	291
Male	RTSPS	r	.741*
		p	.00
		n	276

*p < .01

When Table 5 is examined, it is seen that there is a positive and highly significant relationship between RTSPS and metacognitive awareness levels of both female and male secondary school students ($r_{female} = .701$, $p < .01$) / $r_{male} = .741$, $p < .01$). Comparing the standardized values of the correlation coefficients reveals no significant difference between the RTSPS and metacognitive awareness of female and male students.

To find out if there is a significant link between high school students' RTSPS and their levels of metacognitive awareness in each class, a normality test was done on all scale data and class level variables. Pearson Product Moment Correlation was then used to find the answer, which is shown in Table 6. When Table 6 is examined, it is seen that there is a positive and highly significant relationship between 5th, 7th and 8th grade students' reflective thinking skills for problem solving and their metacognitive awareness levels ($r_{5.grade} = .710$, $p < .01$/ $r_{7.grade} = .705$, $p < .01$/ $r_{8.grade} = .783$, $p < .01$). 6th grade students' reflective thinking skills for problem solving and metacognitive awareness levels were found to have a positive and moderately significant relationship ($r_{6.grade} = .685$, $p < .01$). When the standardized values of the correlation coefficients obtained at the class level were compared, it was

determined that the relationship between students' reflective thinking skills towards problem solving and their metacognitive awareness did not show a significant difference.

Table 6. Correlation Analysis Results between RTSPS and Metacognitive Awareness in Class Level Groups

Class Level			Metacognitive Awareness
5th grade	RTSPS	r	.710*
		p	.00
		n	142
6th grade	RTSPS	r	.685*
		p	.00
		n	159
7th grade	RTSPS	r	.705*
		p	.00
		n	159
8th grade	RTSPS	r	.783*
		p	.00
		n	107

*p < .01

Table 7 presents the results of a Pearson correlation analysis between secondary school students' reflective thinking skills for problem solving and their metacognitive awareness levels in relation to their mother's educational level.

Table 7. Correlation Analysis Results between RTSPS and Metacognitive Awareness in Mother's Education Level Groups

Mother's Education Level			Metacognitive Awareness
Primary School	RTSPS	r	.754*
		p	.00
		n	195
Secondary School	RTSPS	r	.689*
		p	.00
		n	203
High School	RTSPS	r	.759*
		p	.00
		n	108
Undergraduate	RTSPS	r	.679*
		p	.00
		n	61

*p<.01

According to Table 7, when the relationship between reflective thinking skills for problem solving and metacognitive awareness levels of secondary school students in mother's education level groups was examined, it was determined that there was a positive and highly significant relationship for primary school (r=.754, p < .01) and high school (r=.759, p < .01) education levels. For secondary school (r=.689, p < .01) and undergraduate (r=.679, p < .01), there was a positive and moderately significant relationship. When the standardized values of the correlation coefficients obtained as a result of the partial correlation analysis according to the mother's education level were compared, it was determined that there was no significant difference in the relationship between students' reflective thinking skills towards problem solving and their metacognitive awareness.

Table 8 presents the results of a Pearson correlation analysis between secondary school students' reflective thinking skills for problem solving and their levels of metacognitive awareness in relation to their father's educational level.

Table 8. Correlation Analysis Results between RTSPS and Metacognitive Awareness in Father's Education Level Groups

Father's Education Level			Metacognitive Awareness
Primary School	RTSPS	r	.726*
		p	.00
		n	114
Secondary School	RTSPS	r	.658*
		p	.00
		n	181
High School	RTSPS	r	.761*
		p	.00
		n	140
Undergraduate	RTSPS	r	.761*
		p	.00
		n	132

*p<.01

According to Table 8, when the relationship between reflective thinking skills for problem solving and metacognitive awareness levels of secondary school students in father's education level groups was examined, it was determined that there was a positive and highly significant relationship for primary school (r=.726, p < .01), high school (r=.761, p < .01), undergraduate education (r=.761, p < .01) education levels. However, a positive and moderately significant relationship was found for secondary school (r=.658, p < .01) education level. When the standardized values of the correlation coefficients obtained as a result of the partial correlation analysis according to the father's education level were compared, it was determined that the relationship between students' reflective thinking skills towards problem solving and their metacognitive awareness did not show a significant difference.

Table 9 presents the results of a Pearson correlation analysis between the metacognitive awareness levels of

secondary school students and their reflective thinking skills for problem solving in relation to the residential variable.

Table 9. Correlation Analysis Results between RTSPS and Metacognitive Awareness in Residential Groups

Residential			Metacognitive Awareness
Village/Town	RTSPS	r	.745*
		p	.00
		n	286
City Center	RTSPS	r	.711*
		p	.00
		n	281

*p<.01

When Table 9 is examined, it is seen that there is a positive and highly significant relationship between reflective thinking skills for problem solving and metacognitive awareness levels of secondary school students living in both village/town (r=.745, p < .01) and city center (r=.711, p < .01). When the standardized values of the correlation coefficients obtained according to the residential of the secondary school students were compared, it was determined that there was no significant difference in the relationship between students' reflective thinking skills towards problem solving and their metacognitive awareness.

Finally, a simple linear regression analysis was conducted to determine whether secondary school students' RTSPS predicted their metacognitive awareness at a significant level. Table 10 presents the results of the simple linear regression analysis.

Table 10. Simple Linear Regression Analysis Results on RTSPS Predicting Metacognitive Awareness

	B	Standard Error	β	t	p	R	R^2	F
(Constant)	24.551	1.681		14.602	.00			
RTSPS	.880	.035	.726	25.115	.00	.528	.278	630.771

According to Table 10, it was seen that reflective thinking skills for problem solving were a significant predictor of metacognitive awareness (F1-567=630,771; p<0.05). According to the analysis, reflective thinking skills for problem solving explained %53 of metacognitive awareness levels. The regression analysis results indicate that the following regression equation predicts metacognitive awareness of reflective thinking skills for problem solving:

Metacognitive Awareness= 24.551+(0.278* RTSPS)

Conclusion, Discussion and Recommendations

This study examined the relationship between secondary school students' reflective thinking skills for problem

solving and their metacognitive awareness. For this purpose, the problem and sub-problems of the research were examined through the data obtained from secondary school students. Initially, the study examined the reflective thinking skills of the participating secondary school students, revealing a medium level of skill in the sub-dimensions of questioning, evaluation, and reasoning, as well as the overall scale. General examination of the scale revealed scores in the questioning, evaluation, and reasoning sub-dimensions to be close to each other. However, the evaluation dimension yields higher scores. In this context, it can be said that students tend to perform the operations they perform in the problem solving process consciously and tend to have an inquisitive perspective on their own learning, curious to reach the reasons and evaluating their own learning.

Saygılı and Atahan (2014) determined that reflective thinking skills for problem solving were at a high level in their study with students studying in the science and art center. Similarly, Güneş (2015) concluded that Science and Art Center students have high reflective thinking skills towards problem solving. Uygun and Bilgiç (2018) conducted a study that determined the high level of reflective thinking skills among secondary school students towards problem solving. Karademir and Görgün (2019) found that students' reflective thinking skill scores for problem solving were above average in their study. Similarly, in the study conducted by Kozikoğlu and Tunç (2020), it was determined that students' reflective thinking tendencies toward problem solving were at a high level. Altuntaş and Erişen (2021) also determined students' reflective thinking skills towards problem solving as 'most of the time' in their study. Bal (2020) concluded in his study that the students who participated had positive views on reflective thinking towards problem solving. Orman (2021) also found that secondary school students' reflective thinking levels toward problem solving were above average. In the study conducted by Durna (2022), similar results were obtained, and it was determined that the reflective thinking skills of secondary school students towards problem solving were close to the 'most of the time' level.

The study also examined the metacognitive awareness levels of secondary school students. The scale consisting of a single dimension determined that metacognitive awareness was at a 'most of the time' level. This result indicates a high level of metacognitive awareness among students. Karakelle and Saraç (2007) concluded in their study that students' metacognitive awareness levels were high. Çakır and Yaman (2015), in their study with 8th-grade students, determined that students' metacognitive awareness levels were above average. Similarly, Şahin Kürşad (2018), working with 8th grade students, found that the level of metacognitive awareness was above average. In the study conducted by Ağpak (2019), it was seen that students' metacognitive awareness was at the level of 'agree'. Akaydın et al. (2020) determined that metacognitive awareness was at a high level in their study with primary school students. Çalgıcı and Ogan Bekiroğlu (2021), on the other hand, found that students' metacognitive awareness levels were above the secondary level in their study with secondary school students. Bayazıt (2022) found that students' metacognitive awareness levels were above the secondary level according to the findings obtained from his research. Çağlar (2022) also found that students' metacognitive awareness was at a high level in a study conducted with gifted 6th and 7th grade students. In the study conducted by Bakır and Eğmir (2022) with secondary school students, it was concluded that the students' metacognitive awareness was at the 'agree' level. Yelgeç and Dağyar (2020) also reached similar results in their study with seventh and eighth grade students. All these results indicate that secondary school students have a high level of metacognitive awareness.

The study concluded that there was a significant and highly positive relationship between the metacognitive awareness levels of secondary school students and their reflective thinking skills for problem solving. The concepts of metacognition, problem solving, and thinking are closely related to each other (Karakelle & Saraç, 2012). In this context, a high level of metacognitive awareness will have a positive contribution to other concepts. In this study, the high level of positive relationship between metacognitive awareness and reflective thinking skill levels for problem solving shows this positive contribution. Similarly, studies by Metallidou (2009) and Vukman (2005) revealed that metacognitive awareness increases the effectiveness in problem solving. In this context, it can be said that secondary school students' metacognitive awareness levels and reflective thinking skills for problem solving are directly proportional.

When the literature was examined, there was no study directly addressing reflective thinking skills and metacognitive awareness for problem solving. For this reason, studies on similar topics were examined. Güneş (2015) found a significant relationship between reflective thinking skills for problem solving, mathematics achievement, and mathematics course attitudes in his study with Science and Art Center students. Sarıcan (2017) found that integrated STEM education did not significantly increase achievement and reflective thinking skills towards problem solving. Uygun and Bilgiç (2018) determined a significant relationship between students' reflective thinking skills towards problem solving and their academic achievement in the social studies course. Gündoğdu (2017) also found that collaborative learning environments created with Web 2.0 technologies positively affected students' reflective thinking skills toward problem solving.

Babaoğlu (2018) found that the Allestoric learning model in English lessons positively affected students' reflective thinking skills towards problem solving. Altuntaş (2019) concluded that there was a significant positive relationship between reflective thinking skills for problem solving and academic achievement in mathematics courses, indicating that academically successful students think more reflectively than other students. Günen (2019) also found a correlation between reflective thinking skills for problem solving and both routine and non-routine problems in science courses. Şanlıdağ and Aykaç (2021) also determined that intelligence games had a positive effect on students' attitudes towards solving mathematical problems and reflective thinking skills towards problem solving. Orman (2021) concluded that there is a significant positive relationship between secondary school students' perceptions of cognitive flexibility and RTSPS. Durna (2022) found that students' problem-posing self-efficacy and problem-solving attitude were significant predictors of their reflective thinking skills towards problem-posing. Similarly, this study determined a significant positive relationship between reflective thinking skills for problem solving and metacognitive awareness.

The study examined the relationship between secondary school students' reflective thinking skills for problem solving and their metacognitive awareness in terms of demographic variables. The study determined a positive and highly significant relationship between the reflective thinking skills for problem solving and metacognitive awareness of female and male students in terms of the gender variable. Furthermore, researchers observed no significant difference in RTSPS and metacognitive awareness between female and male students. In their study with secondary school students, Kandal and Baş (2021) determined that there was no significant difference in metacognitive awareness levels in terms of the gender variable. Aydın and Kılıç Mocan (2022) examined the

effect of science education on the metacognitive awareness of secondary school students; they concluded that metacognitive awareness did not show a significant difference in terms of the gender variable. Similarly, Erdem et al. (2016) examined the use of information technologies and metacognitive awareness levels according to various variables and found that there was no significant difference between male and female students in terms of metacognitive awareness levels.

The study revealed a positive and highly significant relationship between reflective thinking skills for problem solving and metacognitive awareness levels in 5th, 7th, and 8th-grade secondary school students, while 6th grade students showed a positive and moderately significant relationship. Examining the values of the relationship between reflective thinking skills for problem solving and metacognitive awareness levels revealed that 8th-grade students outperformed other grades. Similarly, Oktay and Çakır (2013) and Bakır and Eğmir (2022) found that metacognitive awareness was in favor of 8th-grade students in their study. The reason for this may be the development of students' mental and metacognitive skills with the increase in the level of education (Weeman et al., 2006). This situation bears resemblance to the findings of Iwai's (2016) study on pre-service teachers, which demonstrated that pre-service teachers' metacognitive awareness peaked at the start of their professional education journey and subsequently exhibited an upward trend. Thus, it can be said that mental maturity and metacognitive development of individuals increase in parallel with the increase in their class levels. In addition, it was observed that there was no significant difference between class levels in reflective thinking skills for problem solving and metacognitive awareness. Gürefe (2015) examined the metacognitive awareness of primary school students according to various variables and concluded that there was no significant difference between class levels. Kapucu and Öksüz (2015) determined that there was no significant difference according to class level in their study in which they examined the metacognitive awareness of secondary school students. Similarly, Kandal and Baş (2021) concluded that metacognitive awareness of secondary school students did not show a significant difference according to class level.

In terms of mother's education level, it was determined that there was a positive and highly significant relationship between reflective thinking skills and metacognitive awareness levels for primary and high school education level. For secondary school and undergraduate education level, there was a positive and moderately significant relationship Furthermore, the study concluded that the relationship between these two phenomena did not significantly differ based on the educational level. In their study, Aydın and Çelik (2013) did not find a significant difference between the RTSPS skills of social studies teacher candidates and the mother’s education level variable. Aktaş (2013) found no significant difference between the metacognitive skill level of participants in the Primary School Teaching department and their mothers' educational status. Ayhan's (2016) study found no significant difference in the sub-dimensions and total score of the metacognition scale among physical education teacher candidates based on the mother's educational status. Koç and Arslan (2017) found no significant differences in the reading strategies and metacognitive awareness of secondary school students based on their mother's educational level.

In terms of father's education level, it was determined that there was a positive and highly significant relationship between reflective thinking skills and metacognitive awareness levels for primary, secondary, high school, and

undergraduate education levels. For secondary school education level, there was a positive and moderately significant relationship. Furthermore, the relationship between these two phenomena did not significantly differ based on the father's education level. In his study, Durna (2022) concluded that secondary school students' reflective thinking skills in problem solving were in favor of master's degree in terms of their father's education level. However, Saygılı and Atahan (2014) concluded in their study that there was no significant effect of parents' education level on reflective thinking skills for problem solving, and Gürefe (2015) concluded that there was no significant effect of parents' education level on metacognitive awareness.

Finally, reflective thinking skills and metacognitive awareness towards problem solving were examined according to the residential variable, and it was determined that there was a positive and highly significant relationship between secondary school students living in both village/town and city center. The residential variable revealed no significant difference in reflective thinking skills and metacognitive awareness towards problem solving. However, an examination of the values demonstrating the relationship between reflective thinking skills for problem solving and metacognitive awareness levels revealed that the village/town variable outperformed the city center variable.

The literature yielded no research at the secondary school level based on the residential variable. However, Erdoğan and Dikicigil (2018) concluded in their study that the metacognitive thinking skills of pre-service social studies teachers were higher in favor of the village/town rather than the city center, which was seen as richer in terms of facilities and opportunities. This aligns with the findings of the current study. The reason for this may be that secondary school students living in villages and towns are not exposed to a wide variety of stimuli and have a development process relatively more intertwined with nature. Dillon et al. (2006) stated in their study that learning activities in nature are more effective in developing cognitive skills than classroom-based learning. This is because nature trips and out-of-school learning are more memorable and leave a stronger impression on students than classroom-based learning does. For this reason, it can be said that out-of-class activities such as excursions, observations, and museum visits will have a positive effect on students' cognitive development.

The overall study and demographic characteristics reveal positive, medium, and high-level significant relationships between secondary school students' reflective thinking skills towards problem-solving and their metacognitive awareness. Furthermore, we found that reflective thinking skills for problem solving significantly predict metacognitive awareness. Therefore, the relationship between secondary school students' reflective thinking skills for problem solving and their metacognitive awareness is linear, and having these skills positively contributes to the development of metacognitive awareness.

Notes

This study was derived from the first author's master's thesis. It was determined with the decision dated 26.10.2022 and numbered 136005 taken by Afyon Kocatepe University Social and Human Sciences Scientific Research and Publication Ethics Committee that this study has no ethical drawbacks.

References

Ağpak, Y. E. (2019). *The relationship between metacognitive awareness levels of secondary school students and mathematical metacognitive awareness levels* [Unpublished master's thesis]. Erzincan Binali Yıldırım University.

Akaydin, B. B., Yorulmaz, A., & Cokcaliskan, H. (2020). Investigation of primary school students' metacognitive awareness and decision-making skill. *International Journal of Progressive Education*, *16*(4), 158-171.

Aktaş, A. (2013). *Interaction between the success level of Turkish teaching courses and attitude and metacognitive skills* [Unpublished master's thesis]. Trakya University.

Altuntaş, L. (2019). *Examining the relationship between math achievement math attitudes and reflective thinking skills towards problem solving of the 7th grade students* [Unpublished master's thesis]. Yıldız Teknik University.

Altuntaş, L., & Erişen, Y. (2021). Investigation into the relationship between the 7th grade students' reflective thinking skills towards problem solving and their math achievement and attitudes. *Türkiye Education Journal*, *6*(1), 280-293.

Aydın, M., & Çelik, T. (2013). The prospective teacher' opinions relating reflective thinking skills. *Pamukkale University Journal of Education*, *34*(34), 169-131.

Aydın, E., & Mocan, D. K. (2022). Examining the role of science education on the metacognitive awareness of middle school students. *Trakya Journal of Education*, *12*(2), 759-770.

Ayhan, A. (2016). *The relationship between prospective physical education teachers' metacognitive awareness and anxiety levels* [Unpublished master's thesis]. Manisa Celal Bayar University.

Babacan, T. (2012). *Searching the correlation between metacognitive reading strategies and multiple intelligences of primary school teacher candidates* [Unpublished master's thesis]. Cumhuriyet University.

Babaoğlu, H. M. (2018). *The effect of allosteric learning model on students' critical thinking skill and reflective thinking skill towards problem solving in 5th grade English course* [Unpublished master's thesis]. Siirt University.

Bakır, T., & Eğmir, E. (2022). Examination of the relationship between secondary school students' critical thinking dispositions and metacognitive awareness. *e-International Journal of Educational Research*, *13*(5), 21-40.

Bal, P. (2020). Investigation of the relationship between reflective thinking skills towards problem solving and mathematics achievements of secondary school students. *Electronic Journal of Social Sciences*, *19*(75), 1063-1074.

Bayazıt, H. (2022). *The analysis of eighth grade students' metacognitive awareness* [Unpublished master's thesis]. Zonguldak Bülent Ecevit University.

Bingham, A. (2004). *Improving problem solving abilities in children* (Ferhat Oğuzkan, Trans.). Ministry of National Education Publications.

Boyd, E. M., & Fales, A. W. (1983). Reflective learning: Key to learning from experience. *Journal of Humanistic*

Psychology, 23, 99-117.

Can, A. (2020). *Quantitative data analysis in the scientific research process with SPSS*. Pegem Akademi Publishing.

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). Sage Publications.

Çağlar, Ç. (2022). *Examination of meta cognitive awareness, problem solving skills and self-efficiency perceptions of high school 6 and 7 secondary students* [Unpublished master's thesis]. Mimar Sinan Fine Arts University.

Çakır, E., & Yaman, S. (2015). The relationship between secondary school students' mental risk-taking skills, metacognitive awareness, and academic achievement. *Gazi Journal of Educational Sciences*, *1*(2), 163-178.

Çalgıcı, G., & Ogan Bekiroğlu F. (2021). Examination of relationship between middle school students' metacognitive awareness and their learning. *Muğla Sıtkı Koçman University Journal of Education, 8*(1), 182-194.

Daudelin, M. W. (1996). Learning from experience through reflection. *Organizational Dynamics*, *24*(3), 36-48.

Demirel, Ö. (2005). *Dictionary of Education*. Pegem Publishing.

Dillon J., Rickinson M., Teamey K., Morris M., Choi M., Sanders D., & Benefield P. (2006). The value of outdoor learning: evidence from research in the UK and elsewhere. *School Science Review, March, 87*(320), 107.

Doğan, Y. (2007). The developmental characteristics of 10 to 14 years old elementary school students. *Uludağ University Faculty of Arts and Sciences Journal of Social Sciences*, *8*(13), 155-187.

Duman, B. (2013). *The effect of an instructional practice based on metacognition upon teacher trainees' academic achievement, metacognitive awareness, achievement motivation and critical thinking* [Unpublished doctoral dissertation]. Fırat University.

Duman, B. (2018). The Relationship between the entrepreneurship characteristics and metacognitive awareness levels of preservice teachers. *Journal of Education and Training Studies, 6*(5), 152-159.

Durna, B. (2022). *Investigation of secondary school students' problem posing self-efficiency, problem solving attitudes and reflective thinking skills for problem solving* [Unpublished master's thesis]. Muğla Sıtkı Koçman University.

Epstein, R. L. & Kernberger, C. (2006). *Critical thinking*. Thomson Wadsworth.

Erdem, E., Cabı, E., & Kırkan, B. (2016). Examination of the utilization of information and communication technologies and meta-cognitive awareness levels of elementary level students in terms of various variables. *Karaelmas Journal of Educational Sciences, 4*(2), 92-103.

Erdoğan, E., & Dikicigil, Ö. (2018). The examination of social studies teacher candidates' metacognitive thinking skills in terms of different variables. *TÜBAV Journal of Science*, *11*(1), 62-73.

Field, A. (2013). *Discovering statistics using SPSS*. Sage Publications.

Flavell, J. H. (1979). Metacognitive and cognitive monitoring: a new area of cognitive developmental inquiry. *American Psychologist*, 34, 906-911.

Fraenkel, J. R., & Wallen, N. E. (2010). *How to design and evaluate research in education*. McGraw-Hill.

Gander, M. J. & Gardiner, H. W. (2001). *Child and adolescent development* (Dönmez, A., Çelen, N. & Bekir Onur, Trans.). İmge Bookstore Publications.

Gelter, H. (2003). Why is reflective thinking uncommon? *Reflective Practice, 4*(3), 337–345.

Graham, B. (1994). *Student journals: A window to metacognitive development* [Unpublished master's thesis]. University of Lethbridge.

Gündoğdu, M. M. (2017). *The effects of Web 2.0 technologies and developed collaborative learning environments on academic achievements, reflective thinking skills for problem solving and the level of motivation of secondary school learners* [Unpublished master's thesis]. Necmettin Erbakan University.

Günen, A. (2019). *The relationship between thinking skills intended for problem solving of 8th grade students and the level of routine and non-routine problem solving* [Unpublished master's thesis]. Kocaeli University.

Güneş, K. (2015). *Analysing the science and art students' reflective thinking skills aimed at solving problem, mathematics successes and attitudes to mathematics lesson* [Unpublished master's thesis]. Çukurova University.

Güney, K. (2008). *The effect of micro- reflective teaching method in accordance with the presentation performance and reflective thinking activities of student- teachers* [Unpublished doctoral dissertation]. Fırat University.

Gürefe, N. (2015). Investigation of metacognitive awareness of secondary school students in terms of some variables. *The Journal of International Education Science,* 5, 237-246.

Iwai, Y. (2016). Promoting strategic readers: Insights of preservice teachers' understanding of metacognitive reading strategies. *International Journal for the Scholarship of Teaching and Learning, 10*(1).

Kandal, R., & Baş F. (2021). The prediction status of secondary school students' metacognitive awareness, self-regulatory learning strategies, anxiety and attitude levels towards mathematics on mathematics achievement. *International Journal of Educational Studies in Mathematics*, *8*(1), 27-43.

Kapucu, M. S., & Öksüz, R. (2015). Examination of secondary school students' metacognitive awareness. *Journal of Education and Humanities: Theory and Practice*, *6*(12), 5-28.

Karademir, Ç. A., & Görgün, S. (2019). Investigation of secondary school students' reflective thinking skills for problem solving and self-regulation skills. *International Journal of Eurasian Researches*, *7*(16), 292-313.

Karakelle, S. (2012). Interrelations between metacognitive awareness, perceived problem solving, intelligence and need for cognition. *Education and Science*, *37*(164), 237-250.

Karakelle, S., & Saraç, S. (2007). Validity and factor structure of Turkish versions of the metacognitive awareness inventory for children (Jr.MAI) - A and B forms. *Turkish Psychology Articles*, *10*(20), 87-103.

Kızılkaya, G., & Aşkar, P. (2009). The development of a reflective thinking skill scale towards problem solving. *Education and Science*, *34*(154), 82-92.

Koç, C., & Arslan, A. (2017). Academic self-efficacy perceptions and metacognitive awareness of reading strategies of secondary school students. *YYU Journal of Education Faculty*, *14*(1), 745-778.

Kozikoğlu, İ., Tunç M. (2020). The relationship between secondary school students' reflective thinking tendencies towards problem solving and perceptions of problem solving skills. *Inonu University Journal of the Faculty of Education, 21*(1), 87-101.

Metallidou, P. (2009). Pre-service and in-service teachers' metacognitive knowledge about problem-solving strategies. *Teaching and Teacher Education*, *25*(1), 76-82.

Mezirow, J. (1991). *Transformative dimensions of adult learning.* Jossey-Bass.

MoNE, (2018). *Mathematics course (grades 1-8) curriculum.* MoNE Publishing House.

Oktay, S., & Çakır, R. (2013). The effect of technology supported brain based learning on students' academic achievement, retention level and metacognitive awareness. *Journal of Turkish Science Education*, *10*(3), 3-23.

Orman, P. (2022). *The relationship between cognitive flexibility and reflective thinking skills towards problem solving of middle school students* (Unpublished Master's Thesis). Erciyes University.

OECD. (2023, December 5). *PISA 2022 results (Volume I and II)-Country notes: Türkiye* https://www.oecd.org/publication/pisa-2022-results/country-notes/turkiye-d67e6c05#chapter-d1e11.

Saban, A. (2005). *Multiple intelligence theory and education*. Nobel Publishing.

Sarıcan. G. (2017). *The impact of integrated STEM education on academic achievement, reflective thinking ability towards problem solving and permanence in learning* [Unpublished master's thesis]. İstanbul Aydın University.

Saygılı, G., & Atahan, R. (2014). Analyzing reflective thinking skills towards problem solving of gifted children in terms of various variables. *Süleyman Demirel University Journal of Humanities and Social Sciences*, 31, 181-192.

Schaaf, M. V., Baartman, L., Prins, F., Oosterbaan, A. & Schaap, H. (2013). Feedback dialogues that stimulate students' reflective thinking. *Scandinavian Journal of Educational Research*, *57*(3), 227-245.

Schön, D. (1987). *Educating the reflective practitioner: Toward a new design for teaching and learning in the professions*. Jossey Bass.

Schraw, G. & Dennison, R. (1994). Assessing metacognitive awareness. *Contemporary Educational Psychology*, 19, 460-475.

Schraw, G. (2001). Promoting general metacognitive awareness. Metacognition in learning and instruction*: Theory, research and practice*, 3-16.

Sperling, R. A., Howard, B. C., Miller, L. A., & Murphy, C. (2002). Measures of children's knowledge and regulation of cognition. *Contemporary Educational Psychology,* 27, 51-79.

Şahin, K. M. (2018). Investigation of eight grade students' metacognitive strategies within the scope of science process skills. *Bolu Abant Izzet Baysal University Journal of Faculty of Education*, *18*(4), 2243-2269.

Şanlıdağ, M., & Aykaç, N. (2021). The effect of mind games on students' attitudes of solving mathematical problems and reflective thinking skills for solving mathematical problems. *Muğla Sıtkı Koçman University Journal of Education*, *8*(2), 597-611.

Tabachnick, B. G. & Fidel, L. S. (2014). *Using multivariate statistics*. Pearson Education Limited.

Uygun, K., & Bilgiç, C. (2018). Reflective thinking skills of elementary school students to solve problems, social studies and academic achievements. *Journal of the Human & Social Science Researches*, *7*(3), 1497-1515.

Ülker, M. (2019). *Investigation of the effect of self-regulation and reflective thinking on mathematics achievement* [Unpublished master's thesis]. Balıkesir University.

Ünver, G. (2003). *Reflective thinking*. Pegem Publishing.

Van de Walle, J. A., Karp, K. S., & Bay-Williams, J. M. (2013). *Elementary and middle school mathematics: Teaching developmentally* (S. Durmuş, Trans.). Nobel Publishing.

Veenman, M. V., Van Hout-Wolters, B. H., & Afflerbach, P. (2006). Metacognition and learning: Conceptual and

methodological considerations. *Metacognition and learning*, *1*, 3-14.

Vukman, K. B. (2005). Developmental differences in metacognition and their connections with cognitive development in adulthood. *Journal of adult development*, *12*, 211-221.

World Economic Forum. (2021). *Annual report 2020-2021.* https://www3.weforum.org/docs/WEF_Annual_Report_2020_21.pdf

Yavuzer, H. (1984). C*hild psychology*. Altın Kitaplar Publishing House.

Yelgeç, N., & Dağyar, M. (2020). A structural equation modelling of middle school students' metacognitive awareness, self-efficacy beliefs and foreign language learning anxiety. *International Journal of Contemporary Educational Research*, *7*(1), 127-148.

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