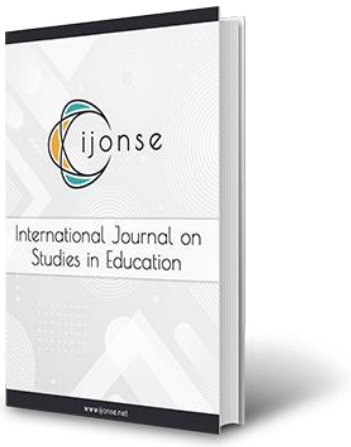

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Abstract

Metacognitive awareness and problem-solving skills are critical for students' academic success. Although studies have shown a positive link between Metacognitive awareness and problem-solving skills, the role of motivational factors—especially self-efficacy—remains underexplored, particularly among middle school students. This gap limits our understanding of how cognitive and affective processes interact in early adolescence. This study aims to examine the mediating role of self-efficacy in the relationship between metacognitive awareness and problem-solving skills among middle school students. A quantitative correlational research design was adopted. The sample consisted of 320 eighth-grade students from public middle schools in Türkiye. Data were collected using validated self-report scales measuring metacognitive awareness, self-efficacy (academic, social, and emotional), and problem-solving skills (confidence, control, and avoidance). Pearson correlations and structural equation modeling were used for data analysis. The results revealed moderate, positive, and significant correlations among metacognitive awareness, self-efficacy, and problem-solving ($r = .48–.49$, $p < .01$). Structural equation modeling confirmed that metacognitive awareness significantly predicted problem-solving skills ($\beta = .59$, $p < .01$), and self-efficacy partially mediated this relationship (indirect effect = .27, $p < .01$; VAF = 31%). The findings indicate that self-efficacy is a key motivational mechanism linking metacognitive awareness to effective problem-solving. This study contributes to the literature by highlighting the mediating role of self-beliefs in cognitive performance among middle school students. Practical implications include integrating metacognitive strategy training and self-efficacy support into classroom instruction.

Introduction

In 21st-century learning environments, students' metacognitive awareness (MA) and problem-solving (PS) skills are increasingly emphasized for academic success and lifelong learning. While problem-solving is among the core competencies identified by the Partnership for 21st Century Skills (2019), metacognitive awareness is widely recognized in educational research as a foundational cognitive process that supports effective learning and adaptability (Akcay et al., 2023; Fleur et al., 2021; Koc & Coral, 2024; Popandopulo et al., 2023). In a world of

constant change and information overload, learners are expected to access and evaluate, manage, and apply knowledge effectively. While MA enables individuals to regulate their thinking, monitor their comprehension, and adapt learning strategies, PS skills empower them to analyze unfamiliar situations, generate alternatives, and make informed decisions. These competencies are essential for academic development and addressing contemporary challenges such as sustainability, digital innovation, and collaborative problem-solving.

Recent studies have revealed that MA plays a significant role in shaping students' PS performance, with higher MA levels contributing to better understanding of problems, appropriate strategy use, and more successful solutions (Güner & Erbay, 2021; Natarajan et al., 2022; Sevgi & Karakaya, 2020; Zerdali & Eğmir, 2025; Utami et al., 2023). Other research confirms a positive and moderate relationship between MA and students' attitudes toward problem solving in various subject areas (Sevgi et al., 2020; Sevgi & Alpaslan, 2023). Moreover, metacognitive instruction has been shown to improve students' mathematical PS performance significantly (Habib et al., 2024), and students with higher MA are more effective in planning, monitoring, and evaluating their strategies (Fauziana & Fazilla, 2022; Yurt, 2022).

Despite extensive research documenting the positive correlation between MA and PS, a critical gap exists in understanding the underlying mechanisms of this relationship. Specifically, no studies have empirically examined whether self-efficacy mediates the MA-PS relationship in middle school contexts, leaving educators without evidence-based strategies to optimize cognitive and affective factors simultaneously. In particular, there is a lack of studies examining potential affective or motivational variables that mediate this relationship, especially in middle school contexts. One such variable is self-efficacy (SE), which refers to an individual's belief in their ability to perform tasks successfully (Bandura, 1997). SE influences students' engagement, emotional regulation, and persistence in the face of cognitive challenges. Students with high SE are more confident in their PS abilities and are less affected by anxiety, stress, and disengagement during the learning process (Açıksöz et al., 2016; Essuman et al., 2025; Şanlı, 2020).

Indeed, recent evidence suggests that SE may enhance performance directly and mediate between cognitive factors and behavioral outcomes. For example, Suliani et al. (2024) found that students with higher mathematical SE beliefs also exhibited stronger use of metacognitive strategies in geometry problem solving. However, despite theoretical support for this relationship, empirical research examining the mediating role of SE in the link between MA and PS skills is scarce, especially among middle school populations. This study investigates the mediating role of SE in the relationship between MA and PS skills among middle school students. By addressing this underexplored pathway, the study seeks to fill a critical gap in the literature and provide a more integrated understanding of how cognitive and affective factors jointly contribute to students' problem-solving capacities. This research is particularly significant for three reasons: First, it provides empirical evidence for a theoretically grounded but underexplored pathway in educational psychology. Second, focusing on middle school students—a critical developmental period when academic self-perceptions crystallize—addresses a population where interventions can have a lasting impact. Third, the findings will inform evidence-based instructional design simultaneously targeting cognitive and motivational factors, potentially enhancing immediate academic performance and long-term learning dispositions.

Conceptual Framework

Problem-solving (PS) is a critical cognitive and behavioral competency that enables individuals to address challenges encountered in daily life. According to D'Zurilla and Goldfried (1971), PS skills encompass individuals' intellectual and behavioral activities to understand problems and develop practical, applicable solutions. Beyond the mere application of learned rules, successful problem-solving also requires higher-order thinking skills such as creative, critical, and analytical thinking (Bailin et al., 1999; Sternberg, 2006). These skills are foundational for academic success and necessary for adapting to real-life complexities. Students with well-developed PS skills are more capable of achieving academic goals, managing stress, and experiencing greater satisfaction in school and personal contexts (Kurt, 2023). Therefore, fostering students' problem-solving abilities is essential for their holistic development and long-term success.

The theoretical foundation of this study rests on the multidimensional nature of problem-solving as conceptualized by Heppner and Peterson (1982). They hypothesize PS skills as comprising three key dimensions: confidence, avoidance, and self-control. Confidence in problem-solving is defined as a student's belief in their ability to effectively handle challenging situations (Serin et al., 2010). This dimension reflects the motivational aspect of problem-solving, where students' perceived competence directly influences their willingness to engage with complex problems. Students with high confidence are likelier to persist, stay motivated, and choose appropriate strategies (Kruger, 1997). Conversely, avoidance delays or evades problem-solving efforts, often driven by fear of failure or anxiety (Arslan, 2005). This dimension represents the behavioral manifestation of students' perceived inability to cope with challenging situations. Self-control relates to regulating cognitive and emotional processes during problem-solving, such as goal-setting, motivation, and time management (Bulut Serin & Derin, 2008). This dimension encompasses the executive function aspects of problem-solving, enabling students to maintain focus and strategic thinking throughout the problem-solving process. Students with high self-control are generally more focused, strategic, and solution-oriented (Saracaloğlu et al., 2005).

Integrating metacognitive awareness (MA) into this framework emerges from its fundamental role in cognitive regulation and strategic thinking. The role of metacognitive awareness (MA) in improving PS skills has been widely acknowledged. MA is an individual's ability to consciously monitor, control, and regulate cognitive and affective activities (Flavell, 1979; Mahdavi, 2014). It encompasses awareness of thinking patterns, emotional regulation, belief systems, intentions, and learning strategies (Hartman, 2001). From a theoretical standpoint, MA serves as the cognitive foundation that enables students to effectively navigate the three problem-solving dimensions by providing the metacognitive tools necessary for strategic thinking and self-regulation. Students with strong MA are more adept at managing learning tasks and using cognitive resources efficiently to navigate complex problems.

The theoretical inclusion of self-efficacy (SE) as a mediating variable stems from its pivotal role in translating cognitive awareness into behavioral action. A variable that may explain how metacognitive awareness (MA) translates into effective problem-solving (PS) is self-efficacy (SE). SE refers to individuals' belief in their capabilities to organize and execute courses of action (Bandura, 1997). This belief system influences academic

motivation, resilience, and emotional regulation (Pajares & Schunk, 2001). According to Bandura's social cognitive theory, SE functions as a crucial mechanism for transforming cognitive capabilities into actual performance, making it a logical mediator between metacognitive awareness and problem-solving behaviors. In particular, academic self-efficacy includes confidence in handling academic tasks, managing time, using strategies, and achieving goals (Zimmerman, 1995; Solberg et al., 1993), while social and emotional self-efficacy beliefs contribute to interpersonal success and emotional well-being (Wei et al., 2005; Mayer & Salovey, 1993).

The proposed theoretical model establishes a sequential relationship where metacognitive awareness provides the cognitive foundation for problem-solving competence. At the same time, self-efficacy serves as the motivational bridge that transforms this awareness into actual problem-solving behaviors. Building on this theoretical foundation, this study proposes that SE mediates MA and PS skills in middle school students. The conceptual framework is grounded in the interrelationships among cognitive monitoring, belief systems, and behavioral outcomes, aiming to contribute to theoretical knowledge and practical educational interventions. The proposed conceptual model is presented in Figure 1, which posits that MA directly predicts PS skills and indirectly influences them through the mediating effect of SE. This theoretical framework suggests that students with high levels of metacognitive awareness will demonstrate enhanced problem-solving skills directly through improved cognitive regulation and indirectly through increased self-efficacy beliefs that motivate sustained engagement with challenging problems.

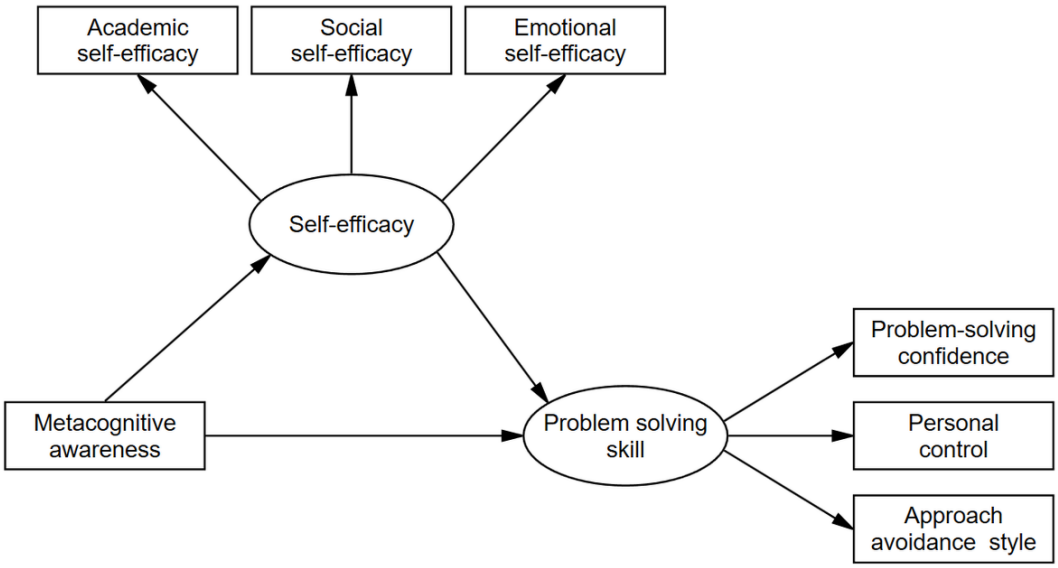

Figure 1. Conceptual Model

Theoretical Background and Hypotheses Development

Metacognitive Awareness and Problem-Solving Skills

Metacognitive awareness (MA) refers to the ability to monitor, evaluate, and regulate one's cognitive processes (Flavell, 1979; Mahdavi, 2014). Students with high levels of MA understand their thought processes and use this awareness to plan, control, and evaluate their learning and problem-solving behaviors (Hartman, 2001). MA plays

a pivotal role in selecting problem-solving strategies, monitoring outcomes, and reflecting on the efficacy of solutions. Extensive empirical research has established a robust foundation for the relationship between metacognitive awareness and problem-solving skills, particularly in middle school. Numerous studies have highlighted a strong and positive association between metacognitive awareness and problem-solving skills, especially among middle school students. For example, Sevgi and Karakaya (2020) reported a moderate, positive correlation between MA and PS skills among 5th to 8th-grade students. Similarly, Sevgi et al. (2020) and Sevgi and Alpaslan (2023) found that MA was significantly associated with students' attitudes and tendencies toward problem-solving, particularly in mathematics. These correlational findings consistently prove that students with higher metacognitive awareness demonstrate superior problem-solving capabilities across various academic domains.

Process-oriented studies have further illuminated how metacognitive awareness enhances problem-solving performance. Güner and Erbay (2021) showed that students with high MA were more capable of understanding problems, selecting appropriate strategies, and reaching accurate solutions. Additionally, Zerdali and Eğmir (2025) found a strong correlation between MA and reflective thinking in the context of problem-solving. These studies demonstrate that metacognitive awareness operates through specific cognitive processes, including problem comprehension, strategy selection, and solution evaluation.

Experimental interventions have provided causal evidence for the relationship between metacognitive awareness and problem-solving skills. Experimental studies have further supported this relationship. Habib et al. (2024) reported that instruction focused on metacognitive strategies significantly improved students' mathematical problem-solving performance. Utami et al. (2023) and Fauziana and Fazilla (2022) demonstrated that students with high levels of MA performed better on science-based problem-solving tasks, showing improved planning and monitoring behaviors. Yurt (2022) emphasized the significant role of metacognitive strategies in students' mathematical reasoning processes. These intervention studies provide compelling evidence that enhancing metacognitive awareness improves problem-solving outcomes.

From an academic performance perspective, research has consistently demonstrated that metacognitive awareness supports deeper learning through enhanced self-monitoring, evaluation, and regulation capabilities. From an academic perspective, MA supports deeper learning through self-monitoring, evaluation, and regulation (Rivas et al., 2022). Empirical evidence has shown that metacognitive strategy instruction improves student performance across subjects (De Boer et al., 2018; Marangoz & Ensar, 2025). Specific to problem-solving, research highlights that students who effectively utilize metacognitive strategies perform better in mathematics (Güner, 2021), science (Durgun & Önder, 2019), and interdisciplinary tasks (Mohamed et al., 2020). Additionally, students with higher MA are better at planning, choosing strategies, and evaluating outcomes (Marić & Sakač, 2018).

These findings suggest that enhancing students' MA is a practical approach for developing stronger PS skills, providing a solid empirical foundation for the proposed direct relationship. Based on this robust empirical evidence, the following hypothesis is proposed:

H1: Middle school students' metacognitive awareness significantly predicts their problem-solving skills.

The Mediating Role of Self-Efficacy

Self-efficacy (SE) is a person's belief in their ability to perform tasks and succeed in specific situations (Bandura, 1997). It influences motivation, emotional regulation, and behavior, especially in academic settings. Students with high SE are more likely to approach challenges confidently, persist through difficulties, and use more effective strategies during problem-solving (Schunk & Pajares, 2009).Emerging research has identified self-efficacy as a crucial mediating mechanism in the relationship between cognitive competencies and behavioral outcomes. Recent research has identified self-efficacy as a potential mediator in the cognitive and behavioral competencies relationship. For example, Akamatsu et al. (2019) found that the use of metacognitive strategies improved students' self-efficacy beliefs, which in turn enhanced their learning outcomes. This finding suggests that metacognitive awareness strengthens students' confidence in their abilities before translating into improved performance. Mohamed et al. (2020) showed that a metacognitive teaching program significantly improved self-efficacy and problem-solving performance. Fadillah and Nurhasanah (2021) emphasized that students with high SE could more efficiently manage the learning process and identify the strategies needed for effective problem-solving. These studies indicate that self-efficacy is a motivational catalyst that transforms cognitive awareness into effective problem-solving behaviors.

Subject-specific research has provided additional evidence for the mediating role of self-efficacy in academic contexts. Suliani et al. (2024) noted that students with high self-efficacy in mathematics also showed stronger metacognitive strategy use when solving geometry problems. This bidirectional relationship suggests that self-efficacy results from metacognitive awareness and facilitates its practical application in problem-solving contexts. Mediation studies have directly tested the role of self-efficacy as an intermediary variable between cognitive and performance outcomes. Furthermore, Hwang and Oh (2021) found that academic SE partially mediated the relationship between self-directed learning and problem-solving skills. Koyuncuoglu (2023) reported that self-efficacy mediated the relationship between metacognition and academic performance, suggesting that SE bridges cognitive awareness and successful task execution. Similarly, Zayed (2024) identified academic self-efficacy as a mediator variable in the relationship between metacognitive awareness and deep learning among university students, further underscoring the integrative role of SE in linking cognitive and motivational factors. These mediation studies provide direct empirical support for the proposed mediating role of self-efficacy in the relationship between metacognitive awareness and problem-solving skills.

The psychological mechanisms underlying this mediation can be understood through motivational regulation. Empirical studies have shown that high SE can reduce anxiety (Anicama et al., 2025; Fürtjes et al., 2023), boost motivation (Basileo et al., 2024; Miao et al., 2025), and enhance the use of cognitive and metacognitive strategies (Essuman et al., 2025; Şanlı, 2020). Individuals with stronger SE are generally more confident in applying metacognitive strategies and persisting through complex tasks (Nie et al., 2011), and this confidence may directly support more effective PS behaviors. These findings suggest that self-efficacy operates as a motivational amplifier that enhances the effectiveness of metacognitive strategies in problem-solving contexts.

Despite theoretical support and related empirical evidence, there remains a significant gap in research directly

examining the mediating role of self-efficacy in the relationship between metacognitive awareness and problem-solving skills among middle school students. However, despite these theoretical connections, the mediating role of SE in the relationship between MA and PS remains largely unexplored, particularly among middle school students. This gap is particularly significant given the developmental nature of the middle school period, where students are developing cognitive and motivational competencies that will influence their academic success.

The limited number of existing studies suggests indirect links between these variables, providing preliminary support for the proposed mediation model. A limited number of existing studies suggest indirect links between these variables. These findings support the plausibility of a mediating role of SE in the MA–PS link, but direct empirical testing is needed to establish this relationship definitively. Given the developmental importance of middle school years and the growing recognition of the need to integrate cognitive and motivational processes in educational research, examining this mediation can provide valuable insights for both theoretical understanding and practical educational interventions. Together, these findings highlight the importance of examining self-efficacy as a mediating mechanism in understanding how metacognitive awareness translates into effective problem-solving, especially during critical developmental stages such as middle school. Despite this evidence, there is a noticeable lack of empirical research directly testing the mediating role of SE in the relationship between MA and PS among middle school students. This study addresses this critical gap by directly testing the mediating role of self-efficacy in the relationship between metacognitive awareness and problem-solving skills among middle school students. Therefore, the following hypothesis is proposed:

H2: Self-efficacy mediates the relationship between middle school students' metacognitive awareness and their problem-solving skills.

Method

Research Model

This study adopted a quantitative (QUAN) research method, as it aimed to examine the relationships between variables statistically through measurable data. In the context of educational research, the QUAN method refers to the systematic investigation of numerical data to identify patterns, test hypotheses, and make predictions. Within this quantitative framework, a correlational research design was used. Correlational design refers to a non-experimental research design in which the direction and strength of relationships between two or more variables are examined without manipulation or intervention (Büyüköztürk et al., 2018). While the method refers to the overall approach to the research (i.e., QUAN), the design refers to the specific strategy used to collect and analyze data (i.e., correlational).In this study, a correlational design was preferred to explore the predictive relationships between metacognitive awareness, self-efficacy, and problem-solving skills among middle school students. The aim was to identify whether metacognitive awareness significantly predicts problem-solving skills and whether self-efficacy mediates in this relationship.

Participants

The participants of this research consisted of 320 eighth-grade students studying in public middle schools located

in the central district of a major city in the Marmara region of Turkey. Eighth-grade students were chosen because this period represents a critical stage in cognitive and emotional development, during which metacognitive strategies and problem-solving abilities become more structured and consciously used. Students were included in the study using the convenience sampling method. This method allows researchers to collect data from participants who are readily accessible in terms of time and resources (Büyüköztürk et al., 2018). This study selected five public middle schools due to their accessibility, administrative approval, and proximity to the researcher's institution. While schools were selected based on convenience, volunteer students from these schools were invited to participate. Participation was entirely voluntary.

Before data collection, ethical approval was obtained from the university's Ethics Committee, and the relevant Provincial Directorate of National Education granted official permissions. Students and their families were informed about the purpose of the research, and informed consent was obtained. Data were collected via a face-to-face paper-based questionnaire administered in classroom settings. The questionnaire took approximately 15 minutes to complete and was administered by the researcher with support from classroom teachers to ensure understanding and consistency. This procedure ensured a standardized data collection environment, contributing to the reliability and validity of the study. Among the participants, 164 students (51.3%) were female and 156 (48.8%) were male. Regarding socioeconomic status, most students (62.2%) reported a middle economic level, while 27.5% described their status as high and 10.3% as low.

Variables and Data Collection Tools

Metacognitive Awareness

The Metacognitive Awareness Scale for Children used in this study was originally developed by Sperling et al. (2002), and its Turkish adaptation was carried out by Karakelle and Saraç (2007). Although the scale is theoretically designed to assess multiple dimensions of metacognitive processes—such as monitoring, task performance, control, and self-awareness—the adaptation study concluded that these sub-dimensions are highly interrelated and could not be reliably distinguished as separate constructs in practice. Therefore, it was recommended that the scale be used as a unidimensional (single-factor) measure for more accurate and consistent results (Karakelle & Saraç, 2007).

The scale includes 18 items and is designed to measure the metacognitive awareness of middle school students. It is a five-point Likert-type scale (1 = never, 5 = always), where higher scores indicate a higher level of metacognitive awareness. In this study, confirmatory factor analysis (CFA) was conducted to determine whether the single-factor structure of the scale fits the current dataset of 320 eighth-grade students. The CFA results showed that the model fit indices were at an acceptable level: $\chi^2 = 157.58$, $\chi^2/df = 1.90$, $p < .001$, CFI = 0.95, RMSEA = 0.05, IFI = 0.95, TLI = 0.91, SRMR = 0.04. These values indicate that the unidimensional structure of the scale is appropriate for the current sample. The standardized factor loadings of the items ranged from 0.36 to 0.72, suggesting that all items contributed meaningfully to the overall construct. The Cronbach's Alpha internal consistency coefficient of the scale was calculated as 0.85, indicating a high level of reliability.

Self-efficacy

The Self-Efficacy Scale for Children, developed by Telef and Karaca (2012), was used in this study to measure students' beliefs in their capabilities across different domains. Designed for use with primary and secondary school students, the scale comprises 21 items and is based on a five-point Likert scale (1 = not at all, 5 = very well). It is structured into three interrelated dimensions: academic self-efficacy, social self-efficacy, and emotional self-efficacy. Academic self-efficacy refers to the belief in one's ability to accomplish academic tasks; social self-efficacy reflects confidence in building and maintaining social relationships; and emotional self-efficacy denotes one's perceived competence in managing emotional experiences and responses. High scores on the overall scale indicate a strong general sense of self-efficacy.

In the context of this study, confirmatory factor analysis (CFA) was performed to test the construct validity of the three-factor structure of the scale. The CFA results revealed that the model demonstrated acceptable goodness-of-fit indices: $\chi^2 = 408.66$, $\chi^2/df = 2.31$, $p < .001$, CFI = 0.92, RMSEA = 0.06, IFI = 0.92, TLI = 0.91, SRMR = 0.06. These results support the validity of the three-dimensional structure within the sample of 320 middle school students. The standardized factor loadings for the items ranged from 0.45 to 0.73, indicating that each item significantly contributed to its corresponding dimension. Furthermore, the subscales' reliability coefficients (Cronbach's Alpha) were 0.84 for academic self-efficacy, 0.82 for social self-efficacy, and 0.80 for emotional self-efficacy. These findings indicate that the scale possesses strong internal consistency and is suitable for assessing self-efficacy in middle school populations.

Problem-solving Skill

In order to assess students' self-perceived problem-solving abilities, the Problem-Solving Inventory (PSI) developed by Serin et al. (2010) for primary school children was utilized in this study. The PSI is a 24-item, five-point Likert-type scale, ranging from "I never act like this" to "I always act like this", designed to measure how frequently students engage in certain behaviors during problem-solving. The inventory comprises three distinct but interrelated dimensions: confidence in problem-solving skills, personal control, and avoidance. Confidence reflects the student's belief in their ability to solve problems effectively; personal control pertains to their perceived ability to regulate their actions during problem-solving; and avoidance refers to the tendency to delay or evade dealing with problems.

Confirmatory factor analysis was conducted on data collected from 320 middle school students to examine the construct validity of the PSI within the context of this research. The results indicated that the three-factor model had acceptable fit indices: $\chi^2 = 537.23$, $\chi^2/df = 2.20$, $p < .001$, CFI = 0.91, RMSEA = 0.06, IFI = 0.91, TLI = 0.90, SRMR = 0.06. The standardized factor loadings for the items ranged from 0.40 to 0.81, suggesting that each item made a meaningful contribution to its corresponding dimension. In addition, the scale demonstrated strong internal consistency, with Cronbach's Alpha coefficients of 0.88 for the confidence in problem-solving skills subscale, 0.76 for the personal control subscale, and 0.84 for the avoidance subscale. These results confirm that the PSI is a valid and reliable instrument for assessing self-perceived problem-solving skills in middle school students.

Gender

The genders of the middle school students who participated in the research were controlled in the research model, considering the potential effect on problem-solving skills, which is the study's dependent variable. Studies show contradictory findings about whether gender affects students' problem-solving skills. Some studies claim that problem-solving skills may differ according to gender (Koray & Azar, 2008; Walker et al., 2002). However, other studies suggest that problem-solving skills do not significantly vary based on gender (Kaymakcı & Can, 2021; Kazu & Ersözlü, 2008). Zhu (2007) interpreted these inconsistent findings by referring to a complex interplay of biological, psychological, and environmental factors influencing gender differences.

In the context of middle school students in Türkiye, recent findings similarly indicate a mixed pattern. For instance, Sevgi and Karakaya (2020) found no significant gender difference in problem-solving skills among middle school students, although they reported a female advantage in metacognitive awareness. Conversely, Sevgi et al. (2020) observed that male middle school students outperformed females in problem-solving tasks. Likewise, Sevgi and Alpaslan (2023) reported no significant gender-based difference in students' attitudes toward problem-solving. Yurt (2022) highlighted that female students used more metacognitive strategies in mathematics lessons and that these strategies partially mediated the gender difference in mathematical reasoning skills. Taken together, the trend in Türkiye among middle school students does not suggest a consistent gender-based pattern in problem-solving skills. Instead, it reflects variability across different studies, with some reporting gender neutrality and others identifying performance differences that metacognitive factors may mediate.

Statistical Analysis

Skewness and kurtosis coefficients were calculated to examine the distribution of scores obtained from metacognitive awareness, problem-solving, and self-efficacy scales. The primary purpose of these calculations is to determine how symmetrical and close to the normal distribution the scores are. In this context, finding the skewness and kurtosis coefficients in the range ±1 is sufficient to meet the normal distribution assumption (Hair et al., 2013). It is determined that the calculated coefficients are within the specified range (-.53≤Skewness≤.78, -.69≤Kurtosis≤.55), and the scale scores have a normal distribution.

Pearson correlation coefficients and the relationships between metacognitive awareness, problem-solving, and self-efficacy scores were calculated. The mediating role of self-efficacy in the effect of metacognitive awareness on problem-solving skills was tested using structural equation model analysis. Hair et al. (2014) proposed a method that was applied to test the mediator role. In this method, the following steps are applied to test the mediating role: i) The direct effect of the independent variable on the dependent variable is investigated. If this effect is statistically significant, the next step can be taken. ii) The model includes the mediator variable in the second step. At this step, the effect of the independent variable on the mediating variable and the impact of the mediating variable on the dependent variable should be significant. In addition, the resulting indirect effect is expected to be statistically significant. When these conditions are met, the third step is taken. iii) The VAF (Variance Accounted For) value is calculated in the third step. It is calculated with the formula VAF [(Indirect

effect)/ (Indirect effect + Total effect) x 100]. Values of VAF>80 indicate a full mediator and 20 ≤ VAF ≤ 80 a partial mediator role. VAF values < 20 indicate the absence of a mediator role.

Before applying the structural equation model analysis, some assumptions were checked. VIF (Variance Inflation Factor) values were calculated to determine whether there was multicollinearity between the variables. VIF>3 values indicate multicollinearity (Yurt, 2023). The highest VIF value was calculated as 1.91, and it was determined that there was no multicollinearity between the variables. Cook distance values were calculated to control for multivariate outliers. It was understood that the Cook distance values were less than 1, and no multivariate extreme values were in the data set. The Mardia multivariate standardized kurtosis coefficient was calculated to test the multivariate normal distribution assumption. The fact that this coefficient is less than 8 indicates that multivariate normality is achieved (Kline, 2023). In this study, the multivariate kurtosis coefficient of Mardia was calculated as 7.54, and it was determined that the multivariate normal distribution assumption was met. Analyses were performed using SPSS 25.0 and AMOS 24.0 statistical package programs.

Results

Before testing the research hypotheses, preliminary analyses were conducted to examine the relationships among the main variables and to report descriptive statistics for the scale scores. Table 1 presents the means, standard deviations, and Pearson correlation coefficients for metacognitive awareness, self-efficacy, and problem-solving skills.

Table 1. Pearson Correlation Coefficients of the Relationships Between Metacognitive Awareness, Problem-solving, and Self-Efficacy Scores

	Variables	1.	2.	3.	4.	5.	6.	7.	8.	9.
1.	Metacognitive awareness	1								
2.	Problem-solving confidence	.31**	1							
3.	Personal control	.22**	.24**	1						
4.	Approach avoidance style	-.28**	-.25**	-.55**	1					
5.	PSI Total	.48**	.42**	.65**	-.82**	1				
6.	Academic self-efficacy	.40**	.12*	.25**	-.23**	.32**	1			
7.	Social self-efficacy	.34**	.14**	.16**	-.18**	.28**	.43**	1		
8.	Emotional self-efficacy	.41**	.26**	.29**	-.30**	.47**	.51**	.49**	1	
9.	SES Total	.49**	.24**	.28**	-.31**	.47**	.73**	.80**	.85**	1
	Mean	71.47	42.23	23.34	11.54	82.13	26.86	25.38	22.31	74.32
	SD	9.08	10.71	5.92	4.03	16.19	4.89	5.67	6.14	13.84

**p<0,01; N=320

The findings revealed moderate, positive, and statistically significant relationships between metacognitive awareness and both problem-solving skills (r = .48, p < .01) and self-efficacy (r = .49, p < .01). Additionally, self-

efficacy was significantly associated with problem-solving skills ($r = .47$, $p < .01$). These results indicate that higher metacognitive awareness in middle school students is associated with higher levels of self-efficacy and problem-solving ability.

A structural equation model was tested to test the first hypothesis (H1: Middle school students' metacognitive awareness significantly predicts their problem-solving skills.) (see Figure 2). The model fit indices indicated an excellent fit: $\chi^2/df = .54$ ($\chi^2/df \leq 5$), RMSEA = .00 ($0 \leq RMSEA \leq .08$), SRMR = .01 ($0 \leq SRMR \leq .08$), CFI = 1.00 ($.95 \leq CFI \leq 1.0$), IFI = 1.00 ($.95 \leq IFI \leq 1.0$), and TLI = 1.00 ($.95 \leq TLI \leq 1.0$), in line with the recommendations of Hu and Bentler (1999). Metacognitive awareness significantly predicted problem-solving skills ($\beta = .59$, 95% CI [.44, .73], $p < .01$), supporting H1. Gender, included as a control variable, did not significantly predict problem-solving skills ($\beta = .12$, 95% CI [-.03, .28], $p > .05$). The model explained 34% of the variance in problem-solving skills ($R^2 = .34$).

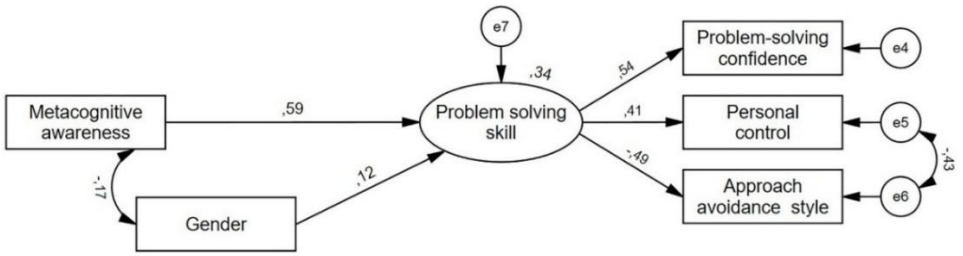

Figure 2. The Structural Equation Model Testing the Direct Effect of Metacognitive Awareness on Problem-solving Skills

To test the second hypothesis (H2: Self-efficacy mediates the relationship between middle school students' metacognitive awareness and their problem-solving skills), self-efficacy was included in the model as a mediating variable (see Figure 3).

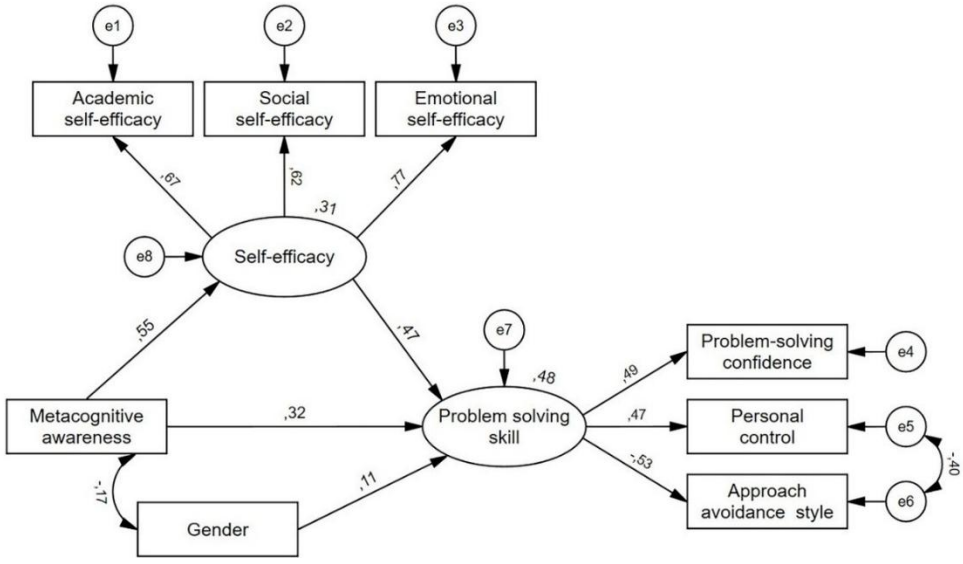

Figure 3. Structural Equation Model Testing the Mediator Role of Self-Efficacy in the Relationship between Metacognitive Awareness and Problem-solving Skills

The model fit indices also indicated an excellent fit: $\chi^2/df = 1.34$ ($\chi^2/df \leq 5$), RMSEA = .03 ($0 \leq RMSEA \leq .08$), SRMR = .03 ($0 \leq SRMR \leq .08$), CFI = .99 ($.95 \leq CFI \leq 1.0$), IFI = .99 ($.95 \leq IFI \leq 1.0$), and TLI = .98 ($.95 \leq TLI \leq 1.0$), in line with the recommendations of Hu and Bentler (1999).

As presented in Table 2, metacognitive awareness significantly predicted self-efficacy (β = .55, 95% CI [.45, .64], p < .01), and self-efficacy significantly predicted problem-solving skills (β = .47, 95% CI [.19, .71], p < .01). The direct effect of metacognitive awareness on problem-solving skills remained significant (β = .32, 95% CI [.08, .53], p < .01). At the same time, the indirect effect through self-efficacy was also significant (β = .27, 95% CI [.10, .42], p < .01). The variance accounted for (VAF) was calculated as 31%, indicating a partial mediation. Thus, H2 was supported.

Table 2. Total, Direct, and Indirect Effects

			β	S.E.	p	%95 CI	
						Lower	Upper
Total Effects							
Metacognitive awareness	--->	Problem-solving skills	.59	.08	<.01	.44	.73
Direct Effects							
Metacognitive awareness	--->	Problem-solving skills	.32	.12	<.01	.08	.53
Metacognitive awareness	--->	Self-efficacy	.55	.05	<.01	.45	.64
Self-efficacy	--->	Problem-solving skills	.47	.13	<.01	.19	.71
Gender [a]	--->	Problem-solving skills	.11	.07	.15	-.04	.25
Indirect Effect							
Metacognitive awareness	--->	Problem-solving skills	.27	.08	<.01	.10	.42

[a] 0= Female, 1= Male, CI= Confidence Interval

Discussion

This study aimed to examine how self-efficacy (SE) mediates the relationship between metacognitive awareness (MA) and problem-solving (PS) skills among middle school students. Adopting a correlational design and using structural equation modeling (SEM), the research investigated direct and indirect paths from MA to PS via SE. The analysis involving 320 eighth-grade students confirmed both hypothesized relationships, providing empirical support for a partially mediated model. The first hypothesis (H1) proposed that metacognitive awareness significantly predicts problem-solving skills. The results supported this hypothesis, showing that MA had a direct and statistically significant effect on PS skills (β = .59, p < .01). This finding aligns with prior studies that reported a positive association between MA and students' problem-solving performance (Sevgi & Karakaya, 2020; Güner & Erbay, 2021; Zerdali & Eğmir, 2025; Utami et al., 2023). Students who are more metacognitively aware are better at planning their actions, monitoring their progress, and evaluating the effectiveness of their strategies—skills that are fundamental to solving problems effectively (Flavell, 1979; Hartman, 2001).

Theoretically, this result supports the notion that metacognition is a higher-order regulatory process that enables

learners to manage their cognitive load and respond adaptively to challenges (Mahdavi, 2014; Rivas et al., 2022). Furthermore, the study expands this evidence base by demonstrating this link within a Turkish middle school population, where developmental transitions make metacognitive growth particularly relevant (Katsantonis, 2024). Unlike prior research that primarily focused on high school or college students, this study sheds light on the early emergence of this association in younger learners, thus contributing to developmental and educational psychology literature. The second hypothesis (H2) posited that self-efficacy would mediate the relationship between MA and PS. SEM analysis confirmed a partial mediation, with MA significantly predicting SE ($\beta = .55$, $p < .01$), and SE, in turn, predicting PS skills ($\beta = .47$, $p < .01$). The indirect effect ($\beta = .27$, $p < .01$) was significant. The VAF was 31%, indicating partial mediation. These results are consistent with the theoretical framework of Bandura (1997), which emphasizes the reciprocal relationship between cognitive competencies and self-beliefs. Students who are more aware of their thinking processes likely develop a stronger sense of control over their academic behaviors, enhancing their confidence in problem-solving situations.

These findings are in line with prior studies that found metacognitive strategy use positively influences SE (Akamatsu et al., 2019) and that SE enhances learning outcomes, persistence, and emotional regulation (Fadillah & Nurhasanah, 2021; Schunk & Pajares, 2009). Moreover, similar to the mediating roles reported by Hwang and Oh (2021) and Koyuncuoglu (2023), this study supports the claim that self-beliefs serve as a critical bridge between metacognition and performance outcomes. One of the distinct contributions of this research is its focus on middle school students, a group often overlooked in mediation-based cognitive-affective models. Additionally, by integrating academic, social, and emotional self-efficacy within the model, this study offers a more holistic view of how beliefs in one's capabilities affect problem-solving behaviors across cognitive and emotional domains. Compared to earlier studies that examined these constructs in isolation, this study presents an integrated model grounded in robust statistical evidence and theoretically coherent reasoning. Consequently, it contributes meaningfully to the literature by clarifying how MA translates into PS success and emphasizing the motivational pathway involving SE.

Limitations and Future Research Suggestions

Despite its valuable contributions, this study has limitations that should be acknowledged. First, using a cross-sectional design restricts the ability to make causal inferences. While structural equation modeling revealed significant relationships among variables, longitudinal or experimental research designs would provide more substantial evidence for directional causality. Second, all data were collected through self-report instruments, which may be affected by social desirability bias or inaccurate self-perceptions. Future studies may incorporate performance-based assessments, observational data, or teacher reports to enhance measurement validity. Third, the research employed a convenience sampling method, focusing on students from five public middle schools in a single region of Türkiye. Although this approach provided accessibility and logistical ease, it limits the generalizability of findings to the broader middle school population. Future studies should consider using stratified or random sampling techniques to include a more diverse and representative sample across various socioeconomic, geographic, and cultural contexts. Finally, this study focused on a single mediating variable—self-efficacy. Future research could explore the roles of other affective or cognitive variables such as academic

resilience, intrinsic motivation, learning strategies, or teacher-student interaction. These factors may offer a more comprehensive understanding of how metacognitive awareness translates into problem-solving ability across different learning environments.

Practical Implications

The findings of this study offer valuable implications for educators, school administrators, and curriculum designers aiming to improve students' academic problem-solving capacities. First, the significant predictive role of metacognitive awareness suggests that schools should implement instructional practices that explicitly teach students how to plan, monitor, and evaluate their thinking. Activities such as think-alouds, reflective journaling, and goal-setting exercises can cultivate metacognitive skills from an early age. Moreover, since self-efficacy was found to mediate the relationship between metacognition and problem-solving, it is important to create classroom environments that promote students' belief in their abilities. Teachers can enhance self-efficacy by providing frequent opportunities for success, emphasizing effort over innate ability, and offering individualized feedback. Importantly, since the self-efficacy construct in this study includes academic, social, and emotional dimensions, interventions should not focus solely on academic skills. Instead, holistic approaches that strengthen students' emotional regulation, interpersonal competence, and motivation are likely to foster more confident and competent problem solvers. These findings should inform educational policies and teacher training programs to support students' cognitive and affective development in a balanced and integrated manner.

Conclusion

This study contributes to understanding how middle school students' metacognitive awareness influences their problem-solving skills and highlights the partial mediating role of self-efficacy in this relationship. By confirming that students are more aware of their thinking processes, feel more confident in their abilities, and perform better in solving problems, the research provides strong empirical support for integrating cognitive and motivational perspectives in educational settings. The results support existing theoretical frameworks and fill a notable gap in the literature by focusing on an understudied population and emphasizing the joint contribution of metacognitive and affective factors to academic success. Future research can extend these findings using longitudinal or mixed-method designs. In contrast, educators can use this knowledge to develop more comprehensive, evidence-based interventions to promote deeper learning, self-belief, and effective problem-solving behaviors in early adolescence.

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References

Açıksöz, S., Uzun, Ş., & Arslan, F. (2016). Assessment of relationship between nursing students' self-efficacy and levels of their anxiety and stress about clinical practice. *Gülhane Medical Journal*, *58*(1), 129-135. doi:10.5455/gulhane.169643

Akamatsu, D., Nakaya, M., & Koizumi, R. (2019). Effects of metacognitive strategies on the self-regulated learning process: The mediating effects of self-efficacy. *Behavioral Sciences*, *9*(12), 128. doi:10.3390/bs9120128.

Akcay, B., Adigüzel, S., Tiryaki, A., & Yavuz, R. (2023). The Effect of Brain-Based Learning on Students' Metacognitive Awareness. *International Journal on Social and Education Sciences*, *5*(3), 676-699.

Anicama, J., Calderón, R., Javier-Aliaga, D., Caballero, G., Talla, K., Pizarro, R., Calizaya-Milla, Y. E., & Saintila, J. (2025). Self-efficacy and stress as predictors of anxiety in Peruvian and Mexican university students: a cross-sectional study. *Front. Educ. 10*, 1423406. doi:10.3389/feduc.2025.1423406

Arslan, C. (2005). Kişilerarası çatışma çözme ve problem çözme yaklaşımlarının yükleme karmaşıklığı açısından incelenmesi. *Selçuk Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 14*, 75-94. Retrieved from https://dergipark.org.tr/tr/download/article-file/1723712

Bailin, S., Case, R., Coombs, J. R., & Daniels, L. B. (1999). Conceptualizing critical thinking. *Journal of Curriculum Studies*, *31*(3), 285-302. doi:10.1080/002202799183133

Bandura, A. (1997). Self-*efficacy: The exercise of control*. Freeman.

Basileo, L. D., Otto, B., Lyons, M., Vannini, N., & Toth, M. D. (2024). The role of self-efficacy, motivation, and perceived support of students' basic psychological needs in academic achievement. *Frontiers in education, 9*, 1385442. doi:10.3389/feduc.2024.1385442

Bulut Serin, N., & Derin, R. (2008). İlköğretim öğrencilerinin kişilerarası problem çözme becerisi algıları ve denetim odağı düzeylerini etkileyen faktörler. *Uluslararası İnsan Bilimleri Dergisi, 5*(1), 1-18. Retrieved from https://core.ac.uk/download/pdf/268072123.pdf

Büyüköztürk, Ş., Kılıç Çakmak, E., Akgün, Ö. E., Karadeniz, Ş., & Demirel, F. (2018). *Eğitimde bilimsel araştırma yöntemleri*. Pegem Akademi.

De Boer, H., Donker, A. S., Kostons, D. D., & Van der Werf, G. P. (2018). Long-term effects of metacognitive strategy instruction on student academic performance: A meta-analysis. *Educational Research Review*, *24*, 98-115. doi:10.1016/j.edurev.2018.03.002

Durgun, E., & Önder, İ. (2019). Ortaokul 7. sınıf öğrencilerinin fen bilimleri başarıları ile okuduğunu anlama, grafik okuma ve problem çözme becerileri arasındaki ilişki. *Journal of Individual Differences in Education*, *1*(1), 1-13. Retrieved from https://dergipark.org.tr/tr/download/article-file/724818

D'Zurilla, T. J., & Goldfried, M. R. (1971). Problem solving and behavior modification. *Journal of Abnormal Psychology, 78*(1), 107–126. doi:10.1037/h0031360

Essuman, B., Barton Essel, H., Steiner, R., Akuteye, A. D., & Essuman, A. B. (2025). Digital literacy, motivation, self-regulation, interest, and task difficulty as predictors of performance in online learning: A path analysis. *International Journal of Current Educational Studies (IJCES), 4*(1), 23-46. doi:10.46328/ijces.164

Fadillah, R., & Nurhasanah, F. (2021, March). The analysis of students' metacognition in solving math problems

based on self-efficacy. In *Journal of Physics: Conference Series* (Vol. 1808, No. 1, p. 012062). IOP Publishing.

Fauziana, F., & Fazilla, S. (2022). The impact of metacognition on elementary school students' problem-solving skills in science learning. *Jurnal Ilmiah Sekolah Dasar, 6*(2), 278–286. doi:10.23887/jisd.v6i2.44889

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry. *American psychologist*, *34*(10), 906-911.

Fleur, D. S., Bredeweg, B., & van den Bos, W. (2021). Metacognition: ideas and insights from neuro- and educational sciences. *npj Sci. Learn. 6*, 13. doi:10.1038/s41539-021-00089-5

Fürtjes, S., Voss, C., Rückert, F., Peschel, S. K., Kische, H., Ollmann, T. M., ... & Beesdo-Baum, K. (2023). Self-efficacy, stress, and symptoms of depression and anxiety in adolescents: An epidemiological cohort study with ecological momentary assessment. *Journal of Mood & Anxiety Disorders, 4*, 100039. doi:10.1016/j.xjmad.2023.100039

Güner, P., & Erbay, H. N. (2021). Metacognitive skills and problem-solving. *International Journal of Research in Education and Science (IJRES), 7*(3), 715-734. doi:10.46328/ijres.1594

Habib, M., Amjad, A. I., Aslam, S., Saleem, Z., & Saleem, A. (2024). Navigating Math Minds: Unveiling the Impact of Metacognitive Strategies on 8th Grade Problem-Solvers Abilities. *International Electronic Journal of Elementary Education, 17*(1), 135-144. doi:10.26822/iejee.2024.368

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2013). *Multivariate data analysis*. Pearson Education Limited.

Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2014). *A primer on partial least squares structural equation modeling*. Sage.

Hartman, H. J. (2001). *Metacognition in learning and instruction: Theory, research and practice* (Vol. 19). Springer Science & Business Media.

Heppner, P. P., & Peterson, C. H. (1982). The development and implications of a personal-problem solving inventory. *Journal of Counseling Psychology, 29*, 66-75. doi:10.1037/0022-0167.29.1.66

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling a Multidisciplinary Journal, 6*(1), 1-55. doi:10.1080/10705519909540118

Hwang, Y., & Oh, J. (2021). The relationship between self-directed learning and problem-solving ability: The mediating role of academic self-efficacy and self-regulated learning among nursing students. *International Journal of Environmental Research and Public Health*, *18*(4), 1738; doi:10.3390/ijerph18041738.

Karakelle, S., & Saraç, S. (2007). Çocuklar için üst bilişsel farkındalık ölçeği (ÜBFÖ-Ç) A ve B formları: Geçerlik ve güvenirlik çalışması. *Türk Psikoloji Yazıları*, *10*(20), 87-103. Retrieved from https://psikolog.org.tr/tr/yayinlar/dergiler/1031828/tpy1301996120070000m000163.pdf

Katsantonis, I. (2024). Exploring age-related differences in metacognitive self-regulation: the influence of motivational factors in secondary school students. *Frontiers in Psychology, 15*, 1383118. doi:10.3389/fpsyg.2024.1383118

Kaymakcı, G., & Can, S. (2021). Investigation of the effects of some variables on middle school students' problem-solving skills, science process skills and learning styles. *Educational Policy Analysis and*

Strategic Research, *16*(1), 394-426. doi:10.29329/epasr.2020.334.21

Kazu, H., & Ersözlü, Z. N. (2008). Öğretmen adaylarının problem çözme becerilerinin cinsiyet, bölüm ve ÖSS puan türüne göre incelenmesi. *Abant İzzet Baysal Üniversitesi Eğitim Fakültesi Dergisi*, *8*(1), 161-172. Retrieved from https://dergipark.org.tr/tr/download/article-file/16613

Kline, R. B. (2023). *Principles and practice of structural equation modeling* (5th Edition). Guilford publications.

Koc, A., & Coral, M. N. Ü. (2024). Development and Validation of the Metacognitive Awareness Scale for Learning with Multimedia. *International Journal of Technology in Education*, *7*(3), 513-534.

Koray, Ö., & Azar, A. (2008). Ortaöğretim öğrencilerinin problem çözme ve mantıksal düşünme becerilerinin cinsiyet ve seçilen alan açısından incelenmesi. *Kastamonu Eğitim Dergisi*, *16*(1), 125-136. Retrieved from https://dergipark.org.tr/en/download/article-file/819068

Koyuncuoglu, D. (2023). The mediating role of general self-efficacy in the relationship between metacognition and academic success of university students. *International Journal of Modern Education Studies, 7*(1), 184-201. doi:10.51383/ijonmes.2023.302

Kruger, L. J. (1997). Social support and self-efficacy in problem solving among teacher assistance teams and school staff. *The Journal of Educational Research, 90*(3), 164–168. doi:10.1080/00220671.1997.10543772

Kurt, I. (2023). World citizenship and the role of education in transition to global situations: One world one homeland. *Journal of Research in Social Sciences and Language, 3*(1), 70-80. doi:10.20375/0000-000d-fedd-d

Mahdavi, M. (2014). An overview: Metacognition in education. *International Journal of Multidisciplinary and Current Research*, *2*(6), 529-535. https://ijmcr.com/wp-content/uploads/2014/05/Paper5529-535.pdf

Marangoz, M. M., & Ensar, F. (2025). The impact of 6+1 traits of writing model on seventh-grade students' fairy tale writing skills and writing attitudes: a mixed methods study. *International Journal of Current Educational Studies, 4*(1), 1-22. doi:10.46328/ijces.159

Marić, M., & Sakač, M. (2018). Metacognitive components as predictors of preschool children's performance in problem-solving tasks. *Psihologija*, *51*(1), 1-16. doi:10.2298/PSI161123007M

Mayer, J. D., & Salovey, P. (1993). The intelligence of emotional intelligence. *Intelligence*, 17(4), 433-442. doi:10.1016/0160-2896(93)90010-3

Miao, H., Guo, R., & Li, M. (2025). The influence of research self-efficacy and learning engagement on Ed. D students' academic achievement. *Frontiers in Psychology, 16*, 1562354.

Mohamed, H. M., Mohamed, A. I., & Abdeen, M. A. (2020). The impact of metacognitive skills educational program on metacognitive awareness, self-efficacy, and problem solving skills among nursing students. *American Journal of Nursing Research*, *8*(2), 289-296. doi:10.12691/ajnr-8-2-19

Natarajan, D., Al Sulaimi, B. H., Lacap, E. M., & Kumar, K. (2022). A comparative study of student mathematical performance in three modes of teaching and learning education during the Covid-19 pandemic. *International Journal of Current Educational Studies, 1*(1), 36-50. doi:10.46328/ijces.1

Nie, Y., Lau, S., & Liau, A. K. (2011). Role of academic self-efficacy in moderating the relation between task importance and test anxiety. *Learning and Individual Differences, 21*(6), 736-741.

Pajares, F., & Schunk, D. H. (2001). Self-beliefs and school success: Self-efficacy, selfconcept, and school achievement, in R. Riding and S. Rayner (Eds.), *Perception*, (pp. 239–266). Ablex Publishing.

Partnership for 21st Century Skills (2019). *Framework for 21st century learning*. Available online: http://www.p21.org/our-work/p21-framework

Popandopulo A., Kudysheva, A., Fominykh, N., Nurgaliyeva, M., & Kudarova, N. (2023). Assessment of students' metacognitive skills in the context of education 4.0. *Front. Educ. 8*, 1182377. doi:10.3389/feduc.2023.1182377

Rivas, S. F., Saiz, C., & Ossa, C. (2022). Metacognitive strategies and development of critical thinking in higher education. *Frontiers in Psychology*, *13*, 1-13. doi:10.3389/fpsyg.2022.913219

Şanlı, C. (2020). The relation between task value, test anxiety and academic self-efficacy: A moderation analysis in high school geography course. *Participatory Educational Research,8*(1), 265-278. doi:10.17275/per.21.15.8.1

Saracaloğlu, A. S., Serin, O., & Bozkurt, N. (2005). Eğitim bilimleri enstitüsü lisansüstü öğrencilerinin problem çözme ve denetim odağı düzeylerinin bazı değişkenler açısından incelenmesi. *Buca Eğitim Fakültesi Dergisi, 17*, 237-242. Retrieved from https://dergipark.org.tr/tr/download/article-file/235005

Schunk, D. H., & Pajares, F. (2009). Self-efficacy theory. In K. R. Wentzel & A. Wigfi eld (Eds.), *Handbook of motivation at school* (pp. 35-53). Routledge.

Serin, O., Serin, N. B., & Saygılı, G. (2010). İlköğretim düzeyindeki çocuklar için problem çözme envanteri'nin (ÇPÇE) geliştirilmesi. *İlköğretim Online*, *9*(2), 446-458. Retrieved from https://dergipark.org.tr/tr/download/article-file/90752

Sevgi, S., & Alpaslan, A.N. (2023). Middle school students' metacognitive attitude in problem solving, metacognition, and mathematical literacy self-efficacy. *Journal of Educational Studies in Science and Mathematics, 2*(1), 1-14. doi:10.29329/jessm.2023.618.1

Sevgi, S., & Karakaya, M. (2020). Investigation of metacognition awareness levels and problem solving skills of middle school students. *International Online Journal of Primary Education, 9*(2), 260-270. Retrieved from https://dergipark.org.tr/en/download/article-file/2404793

Sevgi, S., Macun, Y. & Işık, C. (2020). Investigating middle school students' metacognition and mathematical reasoning of problem-solving skills. *Bartın University Journal of Faculty of Education, 9*(3), 545-563. doi:10.14686/buefad.675770

Solberg, V. S., O'Brien, K., Villareal, P., Kennel, R. & Davis, B. (1993). Self-efficacy and Hispanic college Student: Validation of the college self-efficacy instrument. *Hispanic Journal of Behavioral Sciences, 15*(1), 80-95. doi:10.1177/07399863930151004

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.

Sternberg, R. J. (2006). Creating a vision of creativity: The first 25 years. *Psychology of Aesthetics, Creativity, and the Arts*, *S*(1), 2-12. doi:10.1037/1931-3896.S.1.2

Suliani, M., Juniati, D., & Lukito, A. (2024). Mathematics belief impact on metacognition in solving geometry: Middle school students. *Journal of Education and Learning (EduLearn), 18*(2), 286-295. doi:10.11591/edulearn.v18i2.21110

Telef, B. B., & Karaca, R. (2012). The self-efficacy scale for children; a validity and reliability study. *Buca Eğitim Fakültesi Dergisi, 32*, 169-187. Retrieved from https://dergipark.org.tr/tr/download/article-file/231622

Utami, D. D., Setyosari, P., Fajarianto, O., Kamdi, W., & Ulfa, S. (2023). The correlation between metacognitive

and problem solving skills among science students. *EduLine: Journal of Education and Learning Innovation, 3*(1), 138-143. doi:10.35877/454RI.eduline1702

Walker, S., Irving, K., & Berthelsen, D. (2002). Gender influences on preschool children's social problem-solving strategies. *The Journal of Genetic Psychology*, *163*(2), 197-209. doi:10.1080/00221320209598677

Wei, M., Russell, D. W., & Zakalik, R. A. (2005). Adult attachment, social self-efficacy, self-disclosure, loneliness, and subsequent depression for freshman college students: A longitudinal study. *Journal of Counseling Psychology, 52*(4), 602. doi:10.1037/0022-0167.52.4.602

Yurt, E. (2022). The mediating role of metacognitive strategies in the relationship between gender and mathematical reasoning performance. *Psycho-Educational Research Reviews, 11*(2), 98-120. doi:10.52963/PERR_Biruni_V11.N2.07

Yurt, E. (2023). *Sosyal bilimlerde çok değişkenli analizler için pratik bilgiler: SPSS ve AMOS uygulamaları.* Nobel.

Zayed, A. (2024). Positive academic emotions and academic self-efficacy as mediator variables in the relationship between metacognitive awareness and deep learning among university students. *International Journal of Education and Learning Research, 7*(2), 1-33. doi:10.21608/ijelr.2025.359913.1021

Zerdali, E. & Eğmir, E. (2025). Examining The relationship between secondary school students' reflective thinking skills for problem solving and metacognitive awareness. *International Journal of Education in Mathematics, Science, and Technology (IJEMST),* 13(1), 224- 243. doi:10.46328/ijemst.4256

Zhu, Z. (2007). Gender differences in mathematical problem solving patterns: A review of literature. *International Education Journal*, *8*(2), 187-203. https://files.eric.ed.gov/fulltext/EJ834219.pdf

Zimmerman, B. J. (1995). Self-efficacy and educational development. In A. Bandura (Ed.), *Self-efficacy in changing societies* (pp. 202–231). Cambridge University Press.

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