Investigating the Causal Relationships between Metacognitive Knowledge and Academic Performance in Mathematics through the Mediation of Motivation and Self-Efficacy among Second-Grade High School Students in Babol Province, Iraq

Hayder Abdulhussein Hasan[1]; Mohammad Hassani[2]

[1] PhD student in Educational Management, Department of Educational Sciences, Urmia University, Urmia, Iran

[2] Professor, Department of Educational Sciences, Urmia University, Urmia, Iran

Abstract

The purpose of this research was to examine the causal relationships between metacognitive knowledge and academic performance in mathematics through the mediation of motivation and self-efficacy among second-year high school students in Babil Province, Iraq. The research method was descriptive-correlational, employing structural equation modeling. The statistical population included all second-year high school students in Babil Province, Iraq, totaling 7,500 students. According to Krejcie and Morgan's sampling table (1970), a sample of 382 students was selected using a multi-stage cluster sampling method. Data collection tools included the Metacognitive State Questionnaire by O'Neil and Abedi (1996), the Academic Motivation Scale by Harter (1981), the Student Self-Efficacy Scale by Jinks and Morgan (1999), and the Academic Performance Scale by Dourtaj (2004). The reliability coefficients for the questionnaires were 0.86, 0.77, 0.69, 0.78, and 0.88, respectively. The results showed that the effect coefficient of metacognitive knowledge on motivation among second-year high school students in Babil Province, Iraq, was ($\beta = 0.734$). The effect coefficient of metacognitive knowledge on self-efficacy was ($\beta = 0.631$). Additionally, the effect coefficient of metacognitive knowledge on academic performance in mathematics was ($\beta = 0.263$). The effect coefficient of motivation on academic performance in mathematics was ($\beta = 0.296$), and the effect coefficient of self-efficacy on academic performance in mathematics was ($\beta = 0.587$). There was a significant relationship between metacognitive knowledge and academic performance in mathematics through the mediating role of motivation ($r = 0.197$) and the mediating role of self-efficacy ($r = 0.370$). It is recommended that teachers incorporate metacognitive training into their curricula by teaching specific strategies for goal setting, self-monitoring, and reflecting on learning processes.

Keywords: Metacognitive Knowledge; Academic Performance; Motivation; Self-Efficacy

Introduction

Achieving any goal requires understanding and applying the correct strategies and methods to reach it. Learning, as a goal, is no exception to this rule. In light of the fundamental issue raised in this

Investigating the Causal Relationships between Metacognitive Knowledge and Academic Performance in Mathematics through the Mediation of Motivation and Self-Efficacy among Second-Grade High School Students in Babol Province, Iraq

239

research—that passive reception of information and rote memorization are no longer indicators of effective learning for the future—learners are now expected to critically reflect on what they hear and read, analyze relationships between ideas, and engage in decision-making processes. Individuals with similar abilities exhibit varied responses when confronted with learning challenges. Some, despite having high potential, perceive difficulties as insurmountable, appearing limited in capability and doubting that their efforts will lead to success (Sadeghi & Mohtashami, 2020). Conversely, many learning and transfer challenges faced by students stem from a lack of cognitive and metacognitive skills. These learning and study skills—cognitive and metacognitive strategies—are teachable and should be actively incorporated into learning, rather than left to emerge spontaneously. Cognitive and metacognitive processes have the greatest influence on student learning. Teaching metacognitive strategies promotes academic engagement, internal locus of control, positive attribution, achievement motivation, creativity, self-accountability, and self-confidence. It equips individuals to identify problems, test and evaluate their actions, act independently, and develop optimal solutions to various challenges (Karshki, 2021). Cognitive skills encompass a range of behaviors and attitudes, such as time management, planning, acquiring and organizing information, and can extend to study habits, learning processes, and attitudes toward studying. Cognitive strategies are defined as any behavior, thought, or action a learner uses during learning to help organize, store, and retrieve knowledge and skills more effectively for future use (Maleki, 2020).

The main problem in this research is examining how metacognitive knowledge influences mathematics academic performance among high school students in Babil Province, Iraq. Specifically, this study seeks to determine whether this relationship is mediated by key psychological factors: motivation and self-efficacy. It is hypothesized that metacognitive knowledge—students' awareness and control of their learning processes—directly affects academic performance. However, its effectiveness may depend on the level of motivation and confidence students have in their ability to succeed in mathematics. By exploring these mediating factors, the research aims to clarify whether enhancing students' metacognitive skills can lead to better performance in mathematics, particularly when paired with strategies that strengthen motivation and self-efficacy. Addressing the relationship between metacognitive knowledge and academic performance in mathematics, especially through the mediating effects of motivation and self-efficacy, is crucial as it provides insights into factors that can improve student outcomes in a critical subject like mathematics. Mathematics is often seen as challenging, and many students struggle with performance anxiety and lack of confidence, which can hinder their success. Understanding how metacognitive awareness (students' knowledge of their learning strategies), motivation, and self-efficacy (belief in their ability to succeed) interact can lead to targeted interventions that enhance both cognitive and emotional factors contributing to academic success.

This study seeks to answer the question: **Is there a relationship between metacognitive knowledge and academic performance in mathematics through the mediating roles of motivation, self-efficacy, and creativity among second-year high school students in Babil Province, Iraq?**

Research Methodology

The subject of the present research is to examine the causal relationships between metacognitive knowledge and academic performance in mathematics through the mediation of motivation and self-efficacy in second-grade high school students in Babil Province, Iraq. This research is applied in nature and descriptive-correlational in terms of methodology, employing structural equation modeling (relationships between variables) in a quantitative approach. The statistical population of the study consists of all second-grade high school students studying mathematics in Babil Province, Iraq, based on data from the Provincial Education Organization, totaling 7,500 students. Since it is not feasible to select the entire population due to time and cost constraints, a sample size of 382 students was selected using the Krejcie and Morgan (1970) sampling table. The sampling method in this study is cluster random sampling. For data collection, a questionnaire was used, and its description follows:

Metacognitive Knowledge Questionnaire: The metacognitive questionnaire used in this study is the Metacognitive Awareness Inventory developed by O'Neil and Abedi (1996). This test consists of 20 items across four subscales, with five statements assigned to each subscale. The respondent is required to indicate their level of agreement with each statement on a four-point Likert scale (from 1 = not at all to 4 = very much). Examples of statements from the questionnaire include: "When I think, I know I am thinking" and "When I am doing something or studying, I review and correct my work." This questionnaire was designed by Harold O'Neil and Jamal Abedi (1996), focusing on three principles: "person, task, and strategy." The questionnaire has been validated for internal consistency and Cronbach's alpha. Since metacognitive awareness varies over time and in different situations, test-retest reliability is not suitable for this context (O'Neil & Abedi, 1996). In their study, O'Neil and Abedi (1996) found that the construct validity of the test was supported by significant results (p<0.001), with a Cronbach's alpha reliability of 0.76. In the study by Mombini (2015), the reliability was found to be 0.84 using Cronbach's alpha.

Harter's Academic Motivation Questionnaire: This standard questionnaire, developed by Harter (1981), contains 33 items aimed at measuring academic motivation among students. It is a modified version of Harter's original scale (1980, 1981) designed to assess academic motivation. The original scale measures academic motivation using bipolar questions, one pole indicating intrinsic motivation and the other extrinsic motivation. Respondents can only choose one of the external or internal reasons for each item. Since both intrinsic and extrinsic motivations play a role in many academic topics, Leper and colleagues (2005) modified Harter's scale to include separate scales for intrinsic and extrinsic motivation. This questionnaire uses a Likert scale (Never = 1; Rarely = 2; Sometimes = 3; Often = 4; Almost Always = 5).

Self-Efficacy Questionnaire for Students (Jinks & Morgan, 1999): This questionnaire consists of 30 items aimed at measuring students' self-efficacy across various dimensions (ability, effort, perseverance). The items use a Likert scale (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4). Scoring is as follows: for questions 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 17, 18, 21, 24, 25, 26, 28, 29, and 30, a score of 4 is assigned for strongly agree, 3 for somewhat agree, 2 for somewhat disagree, and 1 for strongly disagree. For questions 4, 5, 15, 16, 19, 20, 22, and 23, scoring is reversed, with 4 for strongly disagree, 3 for somewhat disagree, 2 for somewhat agree, and 1 for strongly agree. The total score range is between 30 and 120. If the score is between 30 and 52, it indicates low self-efficacy in the student population.

Academic Performance Questionnaire: Designed and validated by Dartaj (2004), this test contains 48 questions. Some questions measure a single factor, while others measure multiple factors. The questionnaire assesses factors such as perceived self-efficacy, emotional impacts, planning, lack of control over outcomes, and motivation. In the study by Kiyani (2013), the reliability of the questionnaire was confirmed. Negative items are scored in reverse; for example, a score of 1 is given for "strongly agree," and a score of 5 for "strongly disagree." The total score range is between 48 and 240. The reliability coefficients for different factors of academic performance were found to be: Factor 1 (92%), Factor 2 (93%), Factor 3 (73%), Factor 4 (64%), and Factor 5 (72%) (Dartaj, 2004). In the study by Kiyani (2013), the reliability was calculated using Cronbach's alpha, resulting in a coefficient of 0.84.

Findings

Metacognitive knowledge affects the motivation of second-grade high school students in Babil Province, Iraq.

The findings in Table (1) show that the impact coefficient of metacognitive knowledge on the motivation of second-grade high school students in Babil Province, Iraq, is (β = 0.734). Based on the

coefficient of determination (r²), 53.9% of the variance in metacognitive knowledge is shared with the motivation of second-grade high school students in Babil Province, Iraq.

Table (1) Impact coefficient of metacognitive knowledge on the motivation of second-grade high school students in Babil Province, Iraq

Criterion variable: Motivation					
Statistical index Predictor variable	Impact coefficient or Effect size	Square of the effect size or Squared impact coefficient	T-test	significance level	result
metacognitive knowledge	0.734**	0.539	6.692	0.001	hypothesis confirmation

Metacognitive knowledge affects the self-efficacy of second-grade high school students in Babil Province, Iraq.

The findings in Table (2) show that the impact coefficient of metacognitive knowledge on the self-efficacy of second-grade high school students in Babil Province, Iraq, is ($\beta = 0.631$). Based on the coefficient of determination (r²), 39.8% of the variance in metacognitive knowledge is shared with the self-efficacy of second-grade high school students in Babil Province, Iraq.

Table (2) Impact coefficient of metacognitive knowledge on the self-efficacy of second-grade high school students in Babil Province, Iraq

Criterion variable: self-efficacy					
Statistical index Predictor variable	Impact coefficient or Effect size	Square of the effect size or Squared impact coefficient	T-test	significance level	result
metacognitive knowledge	0.631**	0.398	10.432	0.001	hypothesis confirmation

Metacognitive knowledge affects the academic performance in mathematics of second-grade high school students in Babil Province, Iraq.

The findings in Table (3) show that the impact coefficient of metacognitive knowledge on the academic performance in mathematics of second-grade high school students in Babil Province, Iraq, is ($\beta = 0.263$). Based on the coefficient of determination (r²), 6.9% of the variance in metacognitive knowledge is shared with the academic performance in mathematics of second-grade high school students in Babil Province, Iraq.

Table (3) Impact coefficient of metacognitive knowledge on the academic performance in mathematics of second-grade high school students in Babil Province, Iraq

Criterion variable: academic performance in mathematics					
Statistical index / Predictor variable	Impact coefficient or Effect size	Square of the effect size or Squared impact coefficient	T-test	significance level	result
metacognitive knowledge	0.263*	0.069	1.973	0.048	hypothesis confirmation

Motivation affects the academic performance in mathematics of second-grade high school students in Babil Province, Iraq.

The findings in Table (4) show that the impact coefficient of motivation on the academic performance in mathematics of second-grade high school students in Babil Province, Iraq, is ($\beta = 0.296$). Based on the coefficient of determination (r^2), 7.2% of the variance in motivation is shared with the academic performance in mathematics of second-grade high school students in Babil Province, Iraq.

Table (4) Impact coefficient of motivation on the academic performance in mathematics of second-grade high school students in Babil Province, Iraq

Criterion variable: academic performance in mathematics					
Statistical index / Predictor variable	Impact coefficient or Effect size	Square of the effect size or Squared impact coefficient	T-test	significance level	result
Motivation	0.269*	0.072	2.100	0.036	hypothesis confirmation

Self-efficacy affects the academic performance in mathematics of second-grade high school students in Babil Province, Iraq.

The findings in Table (5) show that the impact coefficient of self-efficacy on the academic performance in mathematics of second-grade high school students in Babil Province, Iraq, is ($\beta = 0.587$). Based on the coefficient of determination (r^2), 34.4% of the variance in self-efficacy is shared with the academic performance in mathematics of second-grade high school students in Babil Province, Iraq.

Table (5) Impact coefficient of self-efficacy on the academic performance in mathematics of second-grade high school students in Babil Province, Iraq

Criterion variable: academic performance in mathematics					
Statistical index / Predictor variable	Impact coefficient or Effect size	Square of the effect size or Squared impact coefficient	T-test	significance level	result
self-efficacy	0.587**	0.344	9.505	0.001	hypothesis confirmation

Metacognitive knowledge has an indirect effect on academic performance in mathematics through the mediating role of motivation in second-grade high school students in Babil Province, Iraq.

The findings in Table (6) show that the correlation coefficient between metacognitive knowledge and academic performance in mathematics, with motivation as a mediator, is significant, meaning there is a significant relationship between metacognitive knowledge and academic performance in mathematics through the mediating role of motivation ($r = 0.197$).

Table (6) Correlation coefficient between metacognitive knowledge and academic performance in mathematics with the mediating role of motivation

Criterion variable: academic performance in mathematics			
Statistical index / Predictor variable	Correlation coefficient	significance level	result
metacognitive knowledge * Motivation	0.197**	0.001	hypothesis confirmation

Metacognitive knowledge has an indirect effect on academic performance in mathematics through the mediating role of self-efficacy in second-grade high school students in Babil Province, Iraq.

The findings in Table (7) show that the correlation coefficient between metacognitive knowledge and academic performance in mathematics, with self-efficacy as a mediator, is significant, meaning there is a significant relationship between metacognitive knowledge and academic performance in mathematics through the mediating role of self-efficacy ($r = 0.370$).

Table (7) Correlation coefficient between metacognitive knowledge and academic performance in mathematics with the mediating role of self-efficacy

Criterion variable: academic performance in mathematics			
Statistical index ⟋ Predictor variable	Correlation coefficient	significance level	result
metacognitive knowledge * self-efficacy	0.370**	0.001	hypothesis confirmation

Discussion and Conclusion

Metacognitive knowledge affects the motivation of second-grade secondary school students in Babil province, Iraq. The findings of Table (1) show that the effect coefficient of metacognitive knowledge on the motivation of second-grade secondary school students in Babil province, Iraq is ($\beta = 0.734$). Based on the coefficient of determination (r^2), 53.9% of the variance in metacognitive knowledge on the motivation of second-grade secondary school students in Babil province, Iraq is shared. The results of this hypothesis are consistent with the findings of the studies by Street et al. (2024), Lee (2024), Zeikwick et al. (2023), Marzooki, Jeffery, and Fouzi (2023), Magnus and Lajoome (2022), Beyler and Snowman (2020), Shamsai-Nia and Saadat (2024), Amidi (2019), Gholami (2019), Kiani and Jafari (2017). To explain this hypothesis, it can be said that metacognitive knowledge significantly affects the motivation of second-grade high school students because it enables them to understand and control their learning processes. When students have metacognitive awareness—by recognizing strengths, weaknesses, and improvement strategies—they can better set realistic goals, monitor their progress, and adjust their approach when necessary. This self-regulation ability leads to increased confidence in their abilities, as they realize that effort and effective strategies can lead to improved performance. As a result, students who understand their learning processes are more motivated to face challenges, persist with difficult tasks, and take responsibility for their academic success. In Babil province, Iraq, where students may face various educational and environmental challenges, increasing metacognitive knowledge can be particularly effective in strengthening motivation. When students learn how to think about their thinking and apply strategies to optimize their learning, they are likely to experience a greater sense of control and autonomy. This sense of agency encourages students to actively engage in their studies because they can see the direct impact of their efforts on their performance. By promoting metacognitive skills, educators can help students in Babil province not only progress academically but also develop the self-motivation and resilience needed for success across diverse learning areas.

Metacognitive knowledge affects the self-efficacy of second-grade secondary school students in Babil province, Iraq. The findings of Table (2) show that the effect coefficient of metacognitive knowledge on the self-efficacy of second-grade secondary school students in Babil province, Iraq is ($\beta = 0.631$). Based on the coefficient of determination (r^2), 39.8% of the variance in metacognitive knowledge on the self-efficacy of second-grade secondary school students in Babil province, Iraq is shared. The results of this hypothesis are consistent with the findings of the studies by Street et al. (2024), Lee (2024), Zeikwick et al. (2023), Shamsai-Nia and Saadat (2024), Yaqoubi (2024), Ghorbanzadeh and Poorhossein (2023), Khamasi and Erfani (2021), Motavalli (2020), Taj-Moradi (2020), Mesarabadi (2020), Amidi (2019), Gholami (2019), Kiani and Jafari (2017). To explain this hypothesis, it can be said that metacognitive knowledge significantly influences the self-efficacy of secondary school students in Babil province, Iraq, by increasing their awareness and control over their learning processes. When students

develop metacognitive skills, they become more aware of the strategies and actions they can use to effectively approach tasks, monitor their progress, and adjust their methods when needed. This self-awareness enhances their sense of control and competence, as students realize they have the tools to successfully tackle challenges. As a result, students' belief in their ability to complete assignments and achieve goals—key components of self-efficacy—becomes stronger. They are more likely to approach difficult tasks with confidence, believing they can manage their learning effectively. Additionally, metacognitive knowledge allows students to experience success in a structured and self-regulatory manner, which over time strengthens their self-efficacy. For example, students who can assess their performance and understand what works well can repeat effective strategies in future tasks, creating a consistent track record of achievements. This ongoing process of goal-setting, monitoring, and reflection empowers students to face academic challenges with resilience and strengthens their belief in their capabilities. In Babil province, fostering metacognitive skills in high school students can have a positive and powerful impact on their self-efficacy, encouraging a proactive and confident approach to learning across subjects.

Metacognitive knowledge affects the academic performance in mathematics of second-grade secondary school students in Babil province, Iraq. The findings of Table (3) show that the effect coefficient of metacognitive knowledge on academic performance in mathematics of second-grade secondary school students in Babil province, Iraq is ($\beta = 0.263$). Based on the coefficient of determination (r^2), 6.9% of the variance in metacognitive knowledge on academic performance in mathematics of second-grade secondary school students in Babil province, Iraq is shared. The results of this hypothesis are consistent with the findings of the studies by Street et al. (2024), Tayeffeh Hosseinali (2024), Shamsai-Nia and Saadat (2024), Yaqoubi (2024), Ghorbanzadeh and Poorhossein (2023), Khamasi and Erfani (2021), Motavalli (2020), Tajmardi (2020), Mesarabadi (2020), Amidi (2019), Gholami (2019), Kiani and Jafari (2017). To explain this hypothesis, it can be said that metacognitive knowledge has a significant impact on the academic performance of second-grade secondary school students in Babil province, Iraq, as it equips them with the skills needed for a more effective and strategic approach to learning. When students are aware of their cognitive processes, they can plan, monitor, and evaluate their study methods, leading to a more structured and constructive approach to learning. This self-regulation helps them set clear goals, organize their time effectively, and adjust strategies according to specific tasks, ultimately enhancing their academic success. By actively managing their learning, students become more engaged and goal-oriented, which leads to better understanding and retention of material. Furthermore, metacognitive knowledge helps students tackle academic challenges with resilience and adaptability. Students with strong metacognitive skills are better able to identify weaknesses and adjust their approach when faced with problems, rather than becoming discouraged. This adaptability not only enhances their problem-solving abilities but also strengthens their growth mindset, increasing the likelihood of persistence and success in their studies. In Babil province, fostering metacognitive knowledge in students can play a significant role in improving academic outcomes, as students learn to take responsibility for their learning journey, leading to higher performance across subjects.

Motivation affects the academic performance in mathematics of second-grade secondary school students in Babil province, Iraq. The findings of Table (4) show that the effect coefficient of motivation on academic performance in mathematics of second-grade secondary school students in Babil province, Iraq is ($\beta = 0.296$). Based on the coefficient of determination (r^2), 7.2% of the variance in motivation on academic performance in mathematics of second-grade secondary school students in Babil province, Iraq is shared. The results of this hypothesis align with the findings of the studies by Street et al. (2024), Lee (2024), Zikoik et al. (2023), Merzouki, Jeffrey, and Fawzi (2023), Magnus and Lajoome (2022), Tayeffeh Hosseinali (2024), Shamsai-Nia and Saadat (2024), Yaqoubi (2024), Ghorbanzadeh and Poorhossein (2023), Khamasi and Erfani (2021), Motavalli (2020), Tajmardi (2020), Mesarabadi (2020). To explain this hypothesis, it can be said that motivation plays a significant role in influencing the academic performance of secondary school students in Babil province, Iraq, as it increases students'

willingness to engage with their lessons and put in the necessary effort to succeed. When students are motivated—whether due to personal goals, interest in the subject, or teacher support—they are more likely to actively participate in learning activities, complete assignments, and seek understanding beyond basic requirements. This intrinsic or extrinsic motivation enhances their focus, perseverance, and flexibility, particularly when facing academic challenges, ultimately contributing to improved academic performance. Moreover, motivated students often adopt more effective learning strategies, such as setting specific goals, managing their time wisely, and engaging in self-assessment to track their progress. This active approach to learning allows them to retain information more effectively and perform better in assessments. Therefore, in Babil province, strengthening motivation in students can have a significant impact on academic progress, as students who are inspired to learn are more likely to achieve higher grades, develop stronger study habits, and maintain a positive attitude toward their education.

Self-efficacy affects the academic performance in mathematics of second-grade secondary school students in Babil province, Iraq. The findings of Table (5) show that the effect coefficient of self-efficacy on academic performance in mathematics of second-grade secondary school students in Babil province, Iraq is (β = 0.587). Based on the coefficient of determination (r^2), 34.4% of the variance in self-efficacy on academic performance in mathematics of second-grade secondary school students in Babil province, Iraq is shared. The results of this hypothesis are in line with the findings of the studies by Street et al. (2024), Kang, Kim, and Kang (2019), Shamsai-Nia and Saadat (2024), Yaqoubi (2024), Ghorbanzadeh and Poorhossein (2023), Khamasi and Erfani (2021), Motavalli (2020), Tajmardi (2020), Mesarabadi (2020), Amidi (2019). To explain this hypothesis, it can be said that self-efficacy, or the belief in one's ability to succeed in specific tasks, has a significant impact on the academic performance of second-grade secondary school students in Babil province, Iraq. When students have strong self-efficacy, they approach academic tasks with confidence and engage more in learning activities. This belief in their abilities encourages them to set challenging goals, overcome obstacles, and maintain focus on their studies, which directly improves their academic performance. High self-efficacy also enables students to handle failures more constructively, viewing them as opportunities for growth rather than setbacks, which further enhances resilience and academic success. Additionally, students with high self-efficacy tend to adopt effective study strategies, such as time management, goal setting, and self-monitoring, which contribute to better academic outcomes. They are more likely to seek help when needed and use feedback constructively, optimizing their learning process. In Babil province, supporting students in building self-efficacy can lead to significant academic benefits, as it enables them to take ownership of their learning and strive for excellence. With higher self-efficacy, students are more likely to confidently overcome academic challenges, leading to improved performance across subjects.

Metacognitive knowledge indirectly affects academic performance in mathematics with the mediating role of students' motivation in second-grade secondary school students in Babil province, Iraq. The findings of Table (6) show that the correlation coefficient between metacognitive knowledge and academic performance in mathematics with the mediating role of motivation is significant, meaning there is a significant relationship between metacognitive knowledge and academic performance in mathematics with the mediating role of motivation (r = 0.197). The results of this hypothesis align with the findings of the studies by Street et al. (2024), Lee (2024), Zikoik et al. (2023), Merzouki, Jeffrey, and Fawzi (2023), Magnus and Lajoome (2022), Beyler and Snoman (2020), Kang, Kim, and Kang (2019), Yaqoubi (2024), Ghorbanzadeh and Poorhossein (2023), Khamasi and Erfani (2021), Motavalli (2020), Tajmardi (2020), Mesarabadi (2020), Amidi (2019), Gholami (2019), Kiani and Jafari (2017). To explain this hypothesis, it can be said that metacognitive knowledge indirectly enhances the academic performance of second-grade high school students in mathematics through its positive impact on motivation. When students develop metacognitive skills such as self-awareness in learning, goal-setting, and progress monitoring, they become more aligned with how they can improve and adapt their learning strategies in mathematics. This awareness often increases their confidence and commitment to the subject, as they see a clear link between effort and progress. As a result, this increased motivation leads students

to engage more actively in their mathematics studies, spend more time practicing, and approach challenges with a growth mindset, all of which contribute to better academic performance. Moreover, motivated students are more likely to apply the metacognitive strategies they have developed in their mathematics studies, making their learning process more efficient and effective. Motivation acts as a bridge between metacognitive knowledge and performance, encouraging students to adopt an active and strategic approach to mastering mathematical concepts. In Babil province, strengthening students' metacognitive knowledge can indirectly improve their mathematical performance by fostering a motivated and self-directed learning attitude. This combination of metacognition and motivation enables students to take ownership of their learning and leads to greater success in mathematics.

Metacognitive knowledge indirectly affects academic performance in mathematics with the mediating role of self-efficacy among second-grade secondary school students in the province of Babil, Iraq. The findings of Table (7) show that the correlation coefficient between metacognitive knowledge and academic performance in mathematics with the mediating role of self-efficacy is significant, meaning that there is a significant relationship between metacognitive knowledge and academic performance in mathematics with the mediating role of self-efficacy ($r = 0.370$). The results of this hypothesis are in line with the results of the studies by Street et al. (2024), Lee (2024), Zikoik et al. (2023), Merzouki, Jeffrey, and Fawzi (2023), Magnus and Lajoome (2022), Beyler and Snoman (2020), Kang, Kim, and Kang (2019), Motavalli (2020), Tajmardi (2020), Mesarabadi (2020), Amidi (2019), Gholami (2019), and Kiani and Jafari (2017). To explain this hypothesis, it can be said that metacognitive knowledge indirectly improves the academic performance of second-grade high school students in mathematics by increasing their self-efficacy, which in turn positively affects their performance. When students develop metacognitive skills—such as understanding how to set goals, monitor their progress, and adjust learning strategies—they gain clearer control over their academic tasks. This self-awareness and strategic planning boost their confidence as they recognize their ability to succeed in challenging tasks such as mathematics. With increased self-efficacy, students are more likely to engage more deeply, persist through difficult problems, and approach mathematics with a positive and capable mindset. Higher self-efficacy encourages students to actively and consistently apply metacognitive strategies, enabling them to optimize their study methods and problem-solving approaches in mathematics. This positive belief in their abilities makes them more resilient and adaptable, helping them solve new mathematical concepts effectively. In the province of Babil, strengthening students' metacognitive knowledge indirectly enhances their mathematical performance by fostering self-efficacy, which leads to persistence, engagement, and a proactive approach to learning. Through this pathway, students become better equipped for success in mathematics and, by combining confidence with strategic learning skills, achieve higher performance.

References

Abdelshiheed, M., Moulder, R., Hostetter, J. W., Barnes, T., & Chi, M. (2024). Example, Nudge, or Practice? Assessing Metacognitive Knowledge Transfer of Factual and Procedural Learners. User Modeling and User-Adapted Interaction.

Al-Tamimi, Jaber Abdul Ali (2023): The effectiveness of creativity in activating the mathematical performance of third-grade secondary school students from the perspective of the Diwaniya Education Directorate. Master's thesis, Al-Mustafa International University, Higher Institute of Sciences and Knowledge.

Ghorbanzadeh, Azadeh & Pourhossein, Afrasiab (2022): Investigating the impact of various creativity development techniques on academic self-concept and academic performance in mathematics among female students. Ninth National Conference on Innovative Research in Education, Psychology, Jurisprudence, Law, and Social Sciences, Shirvan.

Investigating the Causal Relationships between Metacognitive Knowledge and Academic Performance in Mathematics through the Mediation of Motivation and Self-Efficacy among Second-Grade High School Students in Babol Province, Iraq

248

Hidayatullah, A., & Csíkos, C. (2024). The Role of Students' Beliefs, Parents' Educational Level, and The Mediating Role of Attitude and Motivation in Students' Mathematics Achievement. The Asia-Pacific Education Researcher, 33(2), 253-262.

Ifdil, I., Bariyyah, K., Dewi, A. K., & Rangka, I. B. (2024). The College Academic Self-Efficacy Scale (CASES); An Indonesian validation to measure the self-efficacy of students. Jurnal Kajian Bimbingan dan Konseling, 4(4), 11.

Karim, A., Bornaa, C. S., Kissi-Abrokwah, B., Mohammed, H., Apoenchir, H. K., Karim, S., ... & Kwakye, D. O. (2023). Effect of Family Background on Female Students' Mathematics Performance. American Journal of Education and Practice, 7(5), 52-73.

Li, E. (2024). The impact of self-efficacy and acculturation on the mathematics performance of immigrant students or minority students with an immigrant background in an urban high school (Doctoral dissertation).

Mukhlibaev, M. (2024). Theoretical Analysis of the Problem of Developing Technical Creativity of Gifted Students in Teaching Technology. Science Promotion, 9(1), 83-90.

Nisa, Y. Y. N., Saputri, W. E., Putri, Z. R., Nurdiana, N., & Khoirurrosyidin, K. (2024). Educational Assistance: Efforts to Increase Learning Motivation for Dharma Wanita Kindergarten Students in Poko Jambon Ponorogo. Jurnal Inovasi Dan Pengembangan Hasil Pengabdian Masyarakat, 2(1).

Saidov, J. D., Qudratov, A. N., Islikov, S. X., Normatova, M. N., & Monasipova, R. F. (2023). Problems of Competency Approach in Developing Students' Creativity Qualities for Creating a Database. Journal of Higher Education Theory & Practice, 23(1).

Shamsa'iniya, Saeed & Ram, Saadat (2023): The relationship between academic self-efficacy and academic performance in mathematics among ninth-grade male students in Kohgiluyeh and Boyer-Ahmad. First International Conference on Interdisciplinary Research in Education and Research.

Silver, A. M., Alvarez-Vargas, D., Bailey, D. H., & Libertus, M. E. (2024). Assessing the association between parents' math talk and children's math performance: A preregistered meta-analysis. Journal of Experimental Child Psychology, 243, 105920.

Street, K. E. S., Malmberg, L. E., & Schukajlow, S. (2024). Students' mathematics self-efficacy: a scoping review. ZDM–Mathematics Education, 1-16.

Tayfeh Hosseinali, Maryam (2023): Investigating the impact of self-efficacy on mathematical performance and reducing anxiety among female elementary school students in Urmia. First International Conference on Top Teachers and Leading Schools in the Third Millennium, Bushehr.

Teng, M. F., & Mizumoto, A. (2024). Validation of metacognitive knowledge in vocabulary learning and its predictive effects on incidental vocabulary learning from reading. International Review of Applied Linguistics in Language Teaching, (0).

Yaqoubi, Hamideh (2023): Investigating the relationship between self-efficacy and academic performance of sixth-grade elementary school students in mathematics in Qazvin, school year 2022-2023. Sixteenth International Conference on Psychology, Counseling, and Educational Sciences.

Yi, S., Zhang, Y., Lu, Y., & Shadiev, R. (2024). Sense of belonging, academic self-efficacy, and hardiness: Their impacts on student engagement in distance learning courses. British Journal of Educational Technology.

Živković, M., Pellizzoni, S., Doz, E., Cuder, A., Mammarella, I., & Passolunghi, M. C. (2023). Math self-efficacy or anxiety? The Role of Emotional and motivational Contributions in math performance. Social psychology of education, 26(3), 579-601.

Copyrights