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Explaining the impact of academic motivation, metacognitive ability, and self-efficacy on students' academic performance using structural equation

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Abstract

Academic success is a key objective in education, benefiting both learners and educational systems. Researchers and educators have long explored factors influencing academic performance, with academic motivation, metacognitive ability, and self-efficacy identified as crucial components. These factors significantly impact students' learning and performance. However, much of the existing research has analyzed these elements individually, often using correlation analysis, qualitative methods, or experimental approaches. While studies confirm a positive relationship between these factors and academic achievement, they rarely offer a comprehensive understanding of their interactive effects. Additionally, the generalizability of findings is limited, as many studies are conducted within specific fields like psychology and social sciences. A more integrated, context-sensitive approach is needed to fully grasp how these factors collectively influence academic success across diverse educational systems.

Keywords: academic motivation, metacognitive ability, self-efficacy

1. Introduction

Academic success and achieving good grades are primary goals at all educational levels, with positive outcomes for both learners and the educational system. Identifying the factors influencing

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students' academic success has always been a significant concern for researchers and educational psychologists (Mega et al., 2014), as well as a challenge for the educational system (Hayat et al., 2020). Among the numerous factors studied, academic motivation, metacognitive ability, and self-efficacy have been shown to play pivotal roles in students' learning and performance (Pekrun & Gänsler, 2002; Anchueva et al., 2017; Kasurkar et al., 2013; Nozari et al., 2024).

However, much of the existing research has focused on the individual impact of these factors, often using correlation analysis, qualitative methods, or experimental approaches (Kramarski et al., 2002). While these studies have demonstrated a positive relationship between academic motivation, metacognitive ability, self-efficacy, and academic performance (Sadi, 2013; Nozari et al., 2024), they often fail to provide a comprehensive and integrated understanding of how these variables interact with one another to influence academic outcomes. Additionally, many studies have been conducted in the fields of psychology, social sciences, and education (Pekrun & Elliot, 2002; Verhasselt & Lohas, 2016; Fallah & Nozari, 2021), raising concerns about the generalizability of their findings to different educational systems and contexts.

The novelty of this study lies in its use of structural equation modeling (SEM) to examine the complex relationships between academic motivation, metacognitive ability, self-efficacy, and academic performance. Unlike previous research that has predominantly employed simpler analytical methods, this study leverages SEM to model the direct and indirect effects among these variables, providing a more holistic understanding of their interplay. Furthermore, while prior studies have primarily focused on Western populations (Govaerts et al., 2008), this research is conducted in the context of Iran, addressing the need for culturally relevant studies that consider the unique challenges faced by students in non-Western educational systems.

Moreover, this study goes beyond traditional cognitive factors such as prior academic achievement and delves into the emotional aspects of learning, which have often been overlooked in the educational literature (Artino et al., 2012). By considering how emotions, academic motivation, metacognitive strategies, and self-efficacy jointly contribute to academic success, this research provides a more comprehensive framework for understanding student performance. This approach is particularly relevant in diverse educational settings, where students' learning strategies and emotional experiences may differ significantly depending on the nature of the academic discipline,

the type of school (public vs. private), and the broader cultural context (Verhagen, 2005; Mee, 2012).

In summary, this study aims to investigate the impact of academic motivation, metacognitive ability, and self-efficacy on students' academic performance using structural equation modeling. By integrating these factors into a single analytical framework and focusing on a non-Western context, this research contributes to a deeper understanding of the complex dynamics that drive academic success, offering valuable insights for educators, policymakers, and researchers alike.

2. Literature Review

2.1 The Impact of Metacognitive Abilities on Academic Performance

In recent years, self-regulated learning, particularly metacognitive abilities (Arah, 2013; Lotfi et al., 2016), has garnered significant attention, with numerous studies being conducted in this area (Ganda et al., 2018). Metacognitive strategies are considered key components of self-regulated learning, enabling learners to plan, monitor, and regulate their cognition (Sen, 2016; Pintrich, 1990; Nozari & Szmelter-Jarosz, 2022). Today, it is believed that learners who utilize metacognitive abilities more effectively are better at organizing study plans, monitoring and evaluating their understanding of materials, taking responsibility, identifying and solving their problems, and striving for deeper learning (Sen & Yilmaz, 2016). These learners are undoubtedly more successful than their peers who lack such strategic skills (Zimmerman, 2011). In this context, it has been confirmed that metacognitive abilities play a crucial role in academic success, as evidenced by various theories and research (Mega & Ronkainen, 2014; Pekrun & Gatz, 2014; Schunk, 2004; Pintrich, 2003; Zimmerman, 2011).

2.2 The Impact of Academic Self-Efficacy on Academic Performance

Academic self-efficacy is one of the key factors influencing academic performance. It refers to students' beliefs and attitudes about their ability to achieve academic success and their confidence in completing academic tasks and learning successfully. Self-efficacy beliefs lead to high performance by increasing commitment, effort, and perseverance (Pintrich, 2003). Learners with high self-efficacy attribute their failures to lack of effort rather than lower ability, whereas those with low self-efficacy attribute their failures to their perceived lower abilities (Puzerkanoglu &

Akim, 2012). Thus, self-efficacy can impact the choice of tasks and the persistence with which they are pursued. In other words, students with low self-efficacy are more likely to fear, avoid, procrastinate, and quickly give up on their tasks (Bandura, 1997; Schunk et al., 2000). Conversely, those with high levels of self-efficacy are more likely to rely on themselves when facing complex problems, making greater efforts, being patient throughout the process, and persisting longer to overcome challenges (Bandura, 1997; Schunk et al., 2000). Therefore, self-efficacy appears to be one of the most important factors in students' academic success. For instance, Chalmers and Garcia found that students' self-efficacy in their first year of university strongly predicts their future performance (Chalmers & Garcia, 2001). Aliami et al. (2017) conducted a study on 214 students and showed that academic self-efficacy has a positive and significant impact on their academic performance. Other studies have also demonstrated that academic self-efficacy significantly affects students' learning, motivation, and academic performance (Ferla, 2009; Putwain et al., 2013; Damensch et al., 2017).

2.3 The Impact of Academic Motivation on Academic Performance

Academic motivation is recognized as one of the most crucial factors influencing students' learning and academic performance. Students with high motivation engage more enthusiastically and diligently in educational activities, ultimately achieving better results (Piraei, 2023). Motivating students to study and improve their academic performance is essential. The way motivation is fostered in students can affect their academic success. Various factors influence students' academic motivation, and motivation plays a fundamental role in altering learners' behavior toward learning. Additionally, motivation significantly impacts academic life and individual success. Motivation is reflected in learners' choice of academic tasks, the time and effort they dedicate to each task, and their persistence in completing academic assignments. Motivation also enables them to effectively deal with obstacles encountered in the learning process. According to the social-cognitive perspective, students' motivation is relatively context-specific. Academic performance depends on various factors, including stress and motivation. Higher motivation also leads to higher academic achievement (Rahdar et al., 2022). Academic motivation is assessed by understanding how cognitive-motivational processes influence activities that are important for academic progress. Academic motivation relates to specific goals, attitudes, and beliefs, the methods of achieving them, and the effort and determination put in (Weiner, 1986). Motivation is as important as the

learning process itself. Students motivated to learn a subject are more likely to engage in activities that aid their learning (Zimmerman et al., 1992). In contrast, unmotivated students do not systematically approach their learning efforts. They may be inattentive during class, lack organization, and fail to review and repeat course materials. Motivation goes beyond the differences in intelligence or academic aptitude to explain the disparity in academic achievement among students with the same learning potential (Ebrahimi & Khaghani Zadeh, 2009). The concept of motivation helps us understand certain truths about behavior and learning. In fact, motivation helps us direct behavioral goals and determine the amount of time spent on various activities. In any educational system, the level of "academic achievement" of students is one of the indicators of success in scientific activities (Javadi, 2016).

Table 1: Research gap

Study	Focus/Variables Studied	Methodology	Key Findings	Research Gap
Arah (2013); Ganda et al. (2018)	Impact of metacognitive abilities on academic performance	Various (e.g., experimental, correlation)	Metacognitive strategies improve academic performance	Lacks a comprehensive model integrating metacognitive abilities with other factors like motivation and self-efficacy
Sen (2016); Pintrich (1990); Zimmerman (2011)	Role of metacognition in self-regulated learning	Literature review, correlation studies	Metacognitive strategies lead to better self-regulation and academic success	Does not address the combined effects of metacognition, self-efficacy, and motivation in a non-Western context
Schunk et al. (2000); Bandura (1997); Puzerkanoglu & Akim (2012)	Influence of self-efficacy on academic tasks and performance	Experimental and longitudinal studies	High self-efficacy improves persistence, task choice, and academic performance	Limited research on how self-efficacy interacts with metacognitive strategies and motivation
Chalmers & Garcia (2001); Aliami et al. (2017)	Self-efficacy as a predictor of academic performance	Quantitative studies (e.g., surveys)	Self-efficacy significantly predicts future academic performance	Focuses on self-efficacy alone; lacks integration with motivation and metacognition
Piraei (2023); Rahdar et al. (2022)	Impact of academic motivation on performance	Quantitative and qualitative studies	Motivation is crucial for academic engagement and success	Research often considers motivation in isolation, not in conjunction with metacognition and self-efficacy

Current Study	Integration of academic motivation, metacognitive abilities, and self-efficacy on academic performance	Structural Equation Modeling (SEM)	Comprehensive analysis of the combined effects of these factors in a non-Western context (Iran)	Addresses gaps by modeling the relationships among motivation, metacognition, and self-efficacy, offering a holistic view in a culturally diverse setting

3. Research Methodology

The current research is classified as an applied study based on its objectives and as a descriptive survey in terms of data collection methods. According to the four approaches to theoretical perspectives—extending or improving existing theories, comparing different theoretical viewpoints, examining a specific phenomenon using various theoretical perspectives, and studying a documented and repetitive phenomenon in a new environment and conditions—this study falls into the fourth category. The research utilizes structural equation modeling (SEM) and the Smart PLS software to test the hypotheses.

The steps involved in conducting this research are as follows:

1. Literature review (thematic literature review),
2. Identifying constructs, variables, and factors related to the research variables,
3. Designing measurement tools,
4. Conducting preliminary field studies,
5. Modifying and refining the measurement tools,
6. Collecting field data,
7. Analyzing the collected data and testing the hypotheses,
8. Drawing conclusions and providing suggestions and recommendations.

The statistical population for this research consists of experts and specialists from the Education Department of Karaj City, with approximately 120 individuals. Given the characteristics of the statistical population, a random sampling method was employed for this study. There are various methods to determine the sample size. Considering the limited population size, the following formula was used to determine the sample size:

- **Cochra formula:**

$$n = \frac{z^2 pq}{d^2} \quad (1)$$

- **Confidence level** = 95% (Z = 1.96)
- **p = q = 0.5**
- **Population size (N)**: 130 individuals
- **Margin of error (d)**: 0.05

Based on the above information, the sample size was determined to be 97 individuals.

To collect data, four tools are typically used: document review, interviews, questionnaires, and observations. In this research, questionnaires and interviews will be employed. Information will be gathered through repeated sessions with experts and specialists, as well as face-to-face meetings with experts from the Karaj Education Department, using both interviews and questionnaires. The collected data will then be analyzed using structural-interpretive modeling techniques and structural equation modeling.

4. Data Analysis

After conducting a descriptive analysis of the data, the inferential analysis is performed to evaluate and test the research hypotheses.

Structural-Interpretive Modeling (ISM)

To start, a 4x4 matrix of indicators was developed to form the structural interaction matrix. This matrix was provided to the managers, who completed it according to the following principles:

- **V**: Variable iii helps in achieving variable jjj.
- **A**: Variable jjj is improved only by variable iii.
- **X**: Variables iii and jjj help each other in achieving their goals.
- **O**: Variables iii and jjj are not related.

Based on the entries in the SSIM (Structural Self-Interaction Matrix):

- If (i,j)(i, j)(i,j) is marked as **V** in the SSIM, then in the reachability matrix, (i,j)(i, j)(i,j) is set to 1 and (j,i)(j, i)(j,i) is set to 0.
- If (i,j)(i, j)(i,j) is marked as **A** in the SSIM, then in the reachability matrix, (i,j)(i, j)(i,j) is set to 0 and (j,i)(j, i)(j,i) is set to 1.
- If (i,j)(i, j)(i,j) is marked as **X**, then in the reachability matrix, both (i,j)(i, j)(i,j) and (j,i)(j, i)(j,i) are set to 1.
- If (i,j)(i, j)(i,j) is marked as **O**, then both (i,j)(i, j)(i,j) and (j,i)(j, i)(j,i) are set to 0.

The reachability matrix is constructed using the structural interaction matrix as outlined above. The matrix transformation follows the rules:

- For **V**: (i,j)=1(i, j) = 1(i,j)=1 and (j,i)=0(j, i) = 0(j,i)=0
- For **A**: (i,j)=0(i, j) = 0(i,j)=0 and (j,i)=1(j, i) = 1(j,i)=1
- For **X**: (i,j)=1(i, j) = 1(i,j)=1 and (j,i)=1(j, i) = 1(j,i)=1
- For **O**: (i,j)=0(i, j) = 0(i,j)=0 and (j,i)=0(j, i) = 0(j,i)=0

Using these relationships, the reachability matrix shown in Table 2 is created.

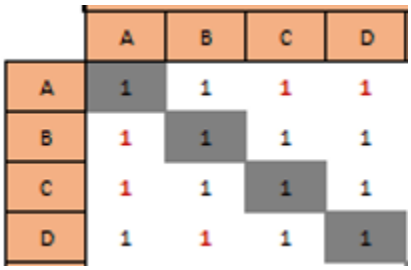
Table 2: Reachability Matrix

	A	B	C	D
A	1	1	0	0
B	0	1	1	1
C	0	1	1	1
D	1	0	1	1

With the reachability matrix obtained, two sets, namely the reachability set and the antecedent set, are defined to determine the criteria. The intersection of these sets is then computed. The reachability set is defined as the set where the row entries of the criteria are represented as one, and the antecedent set is defined as the set where the column entries of the criteria are represented as one. According to the transitivity property in mathematical logic, if (i,j)=1(i, j) = 1(i,j)=1 and (j,k)=1(j, k) = 1(j,k)=1, then (i,k)=1(i, k) = 1(i,k)=1. This means that criteria indirectly affect each

other. The relationship between two variables that connect after applying this logic is represented as 1.

Table 3: Modified Reachability Matrix (Final Reachability Matrix)



	A	B	C	D
A	1	1	1	1
B	1	1	1	1
C	1	1	1	1
D	1	1	1	1

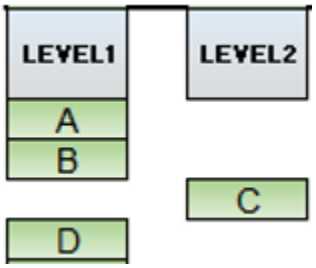
In Table (3), considering the transitivity relationship, if iii and jjj are related and kkk and jjj are related, then iii and kkk are also related. Consequently, some entries will be converted to 1. Additionally, the matrix is divided into various levels using the following method to determine the reachability and antecedent sets for each criterion. The reachability set is defined as the set where the row entries of the criteria are represented as one, while the antecedent set is the set where the column entries of the criteria are represented as one. By obtaining the intersection of these two sets, the next column of the table (Intersection) will be completed. The first row where the intersection of the two sets equals the reachability set will determine the first priority level.

Based on the evaluations conducted in the table and figures above, and using the prioritized levels of criteria and the reachability matrix, the final matrix of driving power and dependence is constructed. In this matrix, the largest number is assigned the highest rank, and the smallest number is assigned the lowest rank. The final reachability matrix must be categorized into different levels. For determining the level of variables in the final model, three sets—output, input, and intersection—are formed for each variable. In the first table, variables whose intersection of output and input sets is identical are considered as common set variables in the hierarchical process, meaning these variables do not affect the creation of any other variables. After identifying these variables, they are removed from the list of other variables. This process continues until all variables' levels are determined. In this study, six levels of variables were obtained in thirteen tables, and the final results are summarized in Table 3. Research indicators whose output and intersection sets are completely identical are placed at the highest level in the structural-interpretive model hierarchy.

The groups depicted are defined as follows:

- **Group 1:** Criteria that have weak power and weak dependence. These variables are almost independent from the system, as they have weak connections with it. In the sample examined, no variables fall into this group.
- **Group 2:** Variables that have weak power but strong dependence.
- **Group 3:** Variables that have both strong power and strong dependence.
- **Group 4:** Variables that have strong power but weak dependence.

Table 4 : First Stage of Level Determination in the ISM Hierarchy



In the last column, the levels are determined as follows: if the intersection of the reachable set and the antecedent set is equal to the reachable set, the corresponding variable is placed at the highest level in the ISM matrix hierarchy. In the ISM graph, the interactions and impacts between criteria and the relationships among criteria at different levels are evident, which enhances the understanding of the decision-making space.

The groups in Table 5 are defined as follows:

- **Group 1:** Criteria with weak power and weak dependence. These variables are almost detached from the system, as they have weak connections with it. In the examined sample, no variables fall into this group.
- **Group 2:** Variables with weak power but strong dependence.
- **Group 3:** Variables with both strong power and strong dependence.
- **Group 4:** Variables with strong power but weak dependence.

Table 5: Stage of Level Determination in the ISM Hierarchy

	Driving forces	Dependent forces
A	17	17
B	18	17
C	17	16
D	17	16

In the last column, levels are determined such that if the intersection of the reachable set and the antecedent set is equal to the reachable set, the corresponding variable is placed at the highest level in the ISM matrix hierarchy. The ISM graph reveals the interactions and impacts between criteria and the relationships among criteria at different levels, which facilitates a better understanding of the decision-making space. The results of the variable level classification are shown in the diagram below:

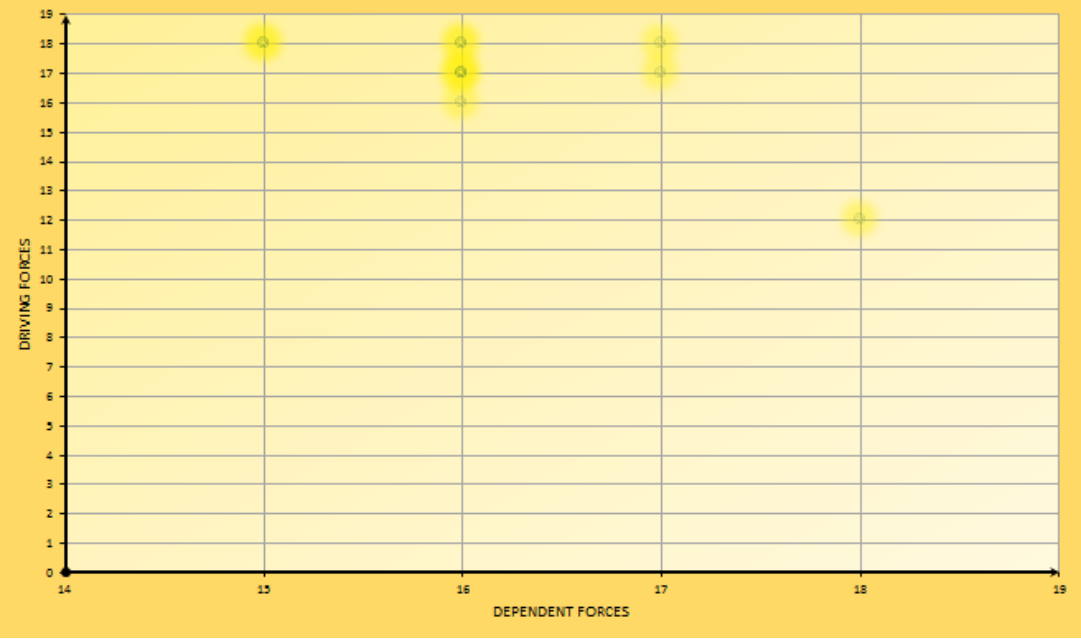


Figure 1: MICMAC Diagram

Testing Hypotheses Using Structured Linear Relationships

At this stage, to evaluate the conceptual model of the research and to ensure the presence or absence of causal relationships among the research variables, as well as to examine the fit of the

observed data with the conceptual model, the research hypotheses were tested using Structural Equation Modeling (SEM). The results of the hypothesis tests are reflected in the diagram.

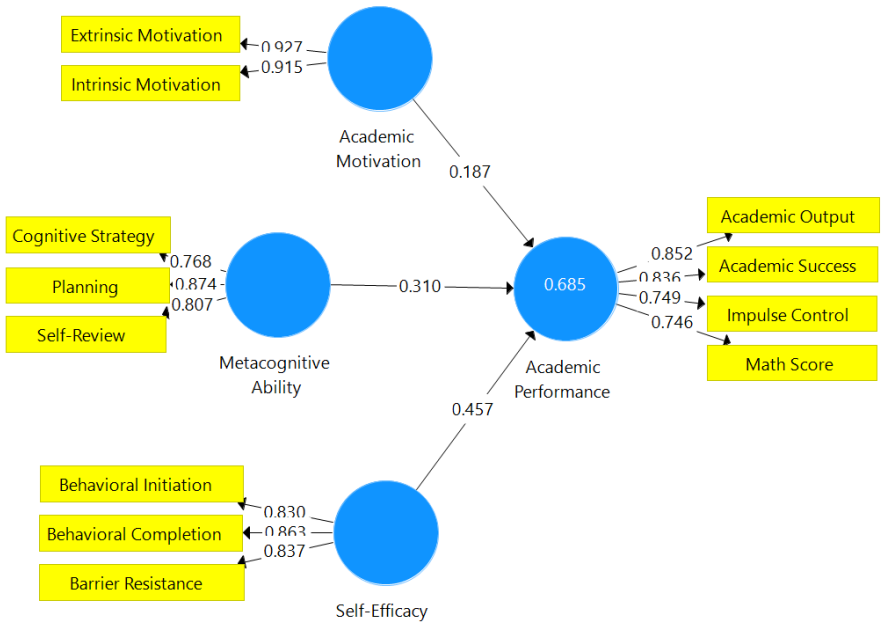


Figure 2: Measurement of the Overall Model and Hypothesis Results in the Standardized State

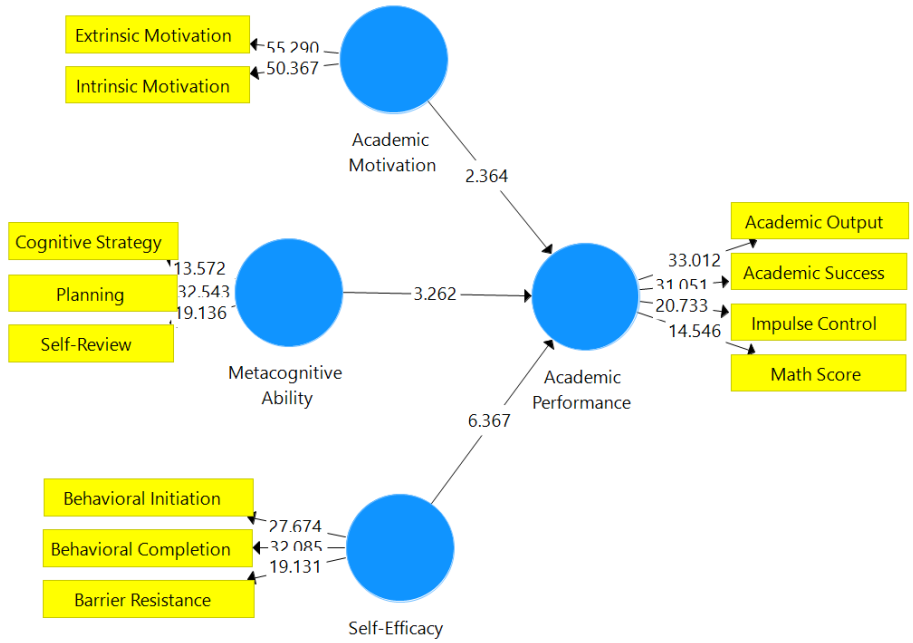


Figure 3: Measurement of the Overall Model and Hypothesis Results in the Significant State

Results of the validity, reliability, and model fit analysis are shown in the table below:

Table 6: Cronbach's Alpha Coefficients

Variables	Composite Reliability	Extracted Variance	Cumulative Variance	R2	Cronbach's Alpha
Academic Motivation	0.883415	0.559085	0.559085	0.439	0.841678
Metacognitive Ability	0.850707	0.592171	0.592171	0.685	0.769435
Self-Efficacy	0.798226	0.508631	0.508631	0.913	0.662904
Academic Achievement	1	1	1	0.928	1

Given the values of 0.01, 0.25, and 0.36 representing weak, moderate, and strong fit respectively for GOF (Goodness of Fit), a GOF value of 0.75 indicates a strong model fit.

Management Applications

The findings of this study offer several practical implications for educational management, particularly in the context of improving students' academic performance through targeted interventions that address academic motivation, metacognitive ability, and self-efficacy.

1. Enhancing Teacher Training Programs:

Educational administrators can incorporate training modules focused on developing teachers' abilities to foster students' metacognitive skills, self-efficacy, and academic motivation. Teachers equipped with these skills can more effectively guide students in adopting self-regulated learning strategies, which, as the study shows, are crucial for academic success.

2. Designing Student Support Programs:

School management can design support programs that specifically target the development of students' self-efficacy and metacognitive abilities. For example, workshops or counseling

sessions can be introduced to help students set realistic academic goals, monitor their progress, and build confidence in their academic abilities.

3. Curriculum Development:

The curriculum can be revised to include components that encourage metacognitive thinking and self-assessment. For instance, integrating reflective assignments that require students to plan, monitor, and evaluate their learning processes can help students develop stronger metacognitive skills.

4. Policy Formulation:

Educational policymakers can use these findings to formulate policies that promote a holistic approach to student development. Policies could encourage schools to adopt comprehensive student development programs that address not just cognitive skills, but also motivational and self-regulatory aspects of learning.

5. Performance Monitoring Systems:

Educational institutions can implement systems that regularly assess not only students' academic performance but also their levels of motivation, metacognitive ability, and self-efficacy. Such systems can help identify students at risk of underperformance early and provide timely interventions.

6. Parental Involvement Initiatives:

Schools can involve parents in the educational process by providing them with strategies to support their children's motivation and self-efficacy at home. This could include workshops or informational sessions that teach parents how to encourage positive academic behaviors and mindsets.

7. Resource Allocation:

School management can allocate resources towards programs and initiatives that directly enhance the factors identified in the study—motivation, metacognition, and self-efficacy. For example, investing in resources such as learning management systems that offer self-paced learning opportunities can cater to diverse student needs.

5. Conclusion

According to Pecron et al. (2007), in the value-control theory, it is assumed that students' cognitive appraisal, such as self-efficacy, influences positive emotions as a personal factor, which in turn affects academic achievement through a cognitive path (metacognitive abilities). Our results strongly support the predictive links between academic self-efficacy, academic motivation, metacognitive abilities, and academic performance. The study findings indicated the impact of academic self-efficacy on positive emotions. As mentioned earlier, based on Pecron's (2007; 2002) value-control theory, cognitive appraisal is one of the important backgrounds of academic emotions, categorized into control appraisals (perceived control) and value appraisals (perceived value). Control appraisals relate to individuals' perceptions of their ability to control progress activities and their outcomes. These appraisals are manifested through expectations and perceptions of competence, such as self-efficacy. Therefore, academic self-efficacy (as a cognitive appraisal) can impact academic emotions (Artino et al., 2006). It can be expected that when students have confidence in their ability to successfully perform their tasks, they enjoy the learning process more. It also seems reasonable that these individuals experience more hope and pride compared to students with lower self-efficacy. Some studies have shown a positive relationship between academic self-efficacy and academic performance. Another finding of this study was the significant relationship between metacognitive abilities and academic performance. Researchers believe that students with more effective metacognitive abilities have better study plans, more effective monitoring and evaluation of learning, and better perceptions of content. They take responsibility for their learning, identify and solve problems, and strive for deeper learning (Pintrich, 1999). They certainly gain more than their peers who lack such skills (38). In this regard, the role of metacognitive abilities in academic success has been well supported by theories and research (Ahmad et al., 2013; Zimmerman, 1990; Zimmerman, 2011; Pintrich, 1990; Sen, 2016; Pintrich, 2003; Stock, 1996). Finally, as hypothesized in our model, the findings showed that the impact of self-efficacy on academic performance depends on multiple relationships and is

influenced by academic motivation and metacognitive abilities. Specifically, self-efficacy positively affects academic performance when mediated by positive emotions and metacognitive learning strategies. Thus, it seems reasonable that students who have faith in their abilities to learn and perform certain academic tasks enjoy learning new material more than others. Since these students believe they have the necessary skills to learn the material, they feel pride during learning. Additionally, because they have faith in their abilities, they are optimistic about their learning and the material they need to learn. Therefore, it is concluded that students with high self-efficacy experience more positive emotions during study and learning, which in turn can lead to better academic performance.

While the findings of this study contribute valuable insights into the relationships between academic motivation, metacognitive abilities, self-efficacy, and academic performance, several limitations should be acknowledged:

1. Sample Size and Demographics: The study was conducted with a specific sample of students from a particular educational context (e.g., a single region or country). As a result, the findings may not be generalizable to students in different educational systems or cultural settings. Future research should consider replicating this study with a larger and more diverse sample to enhance the generalizability of the results.

2. Cross-Sectional Design: The research employed a cross-sectional design, capturing data at a single point in time. This design limits the ability to draw causal inferences about the relationships between the variables. Longitudinal studies are recommended to examine how these relationships evolve over time and to better understand the directionality of the effects.

3. Self-Reported Data: The study relied on self-reported measures for assessing academic motivation, metacognitive abilities, and self-efficacy. Self-reported data are subject to biases such as social desirability and recall bias, which may affect the accuracy of the findings. Future studies could incorporate objective measures or observational data to complement self-reports.

4. Limited Scope of Variables: Although the study focused on three key variables—academic motivation, metacognitive ability, and self-efficacy—other factors, such as environmental influences, peer interactions, and teacher support, were not considered. Including these additional

variables in future research could provide a more comprehensive understanding of the factors influencing academic performance.

5. Cultural and Contextual Factors: The study's findings are based on a specific cultural and educational context, which may differ significantly from other contexts. The impact of cultural factors on the relationships studied should be explored in future research to determine whether the findings can be applied across different cultural settings.

By acknowledging these limitations, you not only provide a balanced view of your research but also pave the way for future studies to build on your work. This section will make your paper more robust and credible, meeting the journal's requirements for discussing limitations in the conclusion.

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