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The Relationship between Cognitive and Metacognitive Skills, Academic Motivation, and Achievement among Freshmen Students

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ABSTRACT

Learning is an inherent characteristic of human beings and plays a significant role in the development of cognition. In this regard, metacognition is a special kind of cognition as it deals with the monitoring and regulation of cognition. It motivates learning in students and improves their academic achievement. This study, therefore, seeks to investigate the interaction between cognitive and metacognitive skills, academic motivation, and academic achievement among freshmen Computer Science and Engineering students at a public university in KSA. Using a descriptive correlation design, a sample of 39 freshmen students from the academic year 2022/2023. Data were collected using established instruments, including the McGregory et al. (2015) Academic Performance Scale, the Wells and Cartwright-Hatton (2004) Metacognition Questionnaire (MCQ-30), the Witkin et al. (1977) Group Embedded Figure Test (GEFT), and the Achievement Motives Scale (Revised) (AMS-R). The gathered data were analyzed using SPSS software (version 23.0), employing simple linear regression and Pearson correlation tests. The findings revealed a significant positive relationship between the implementation of metacognitive and cognitive strategies and academic achievement among freshmen students ($p < 0.05$). Moreover, the study concluded that there is also a significant positive relationship between the adoption of metacognitive and cognitive strategies and learning motivation among these students ($p < 0.05$). Notably, students with a higher level of metacognitive awareness in planning, monitoring, and critical thinking exhibited greater motivation to excel in their academic pursuits. The study recommends that instructional methods should prioritize both cognitive and metacognitive skills to facilitate effective learning experiences for students.

Key words: Cognitive, Metacognitive Skills, Motivation, Critical thinking, Academic Performance, First-year students

INTRODUCTION

Nowadays, academic achievement and motivation to learn are among the crucial factors that have been widely accepted as ways to measure how well education works. Academic achievement represents a kind of hallmark for measuring individual success and shows one's capability to gain knowledge and skills in school subjects, as judged by standardized tests (Napolitano et al., 2021). It is considered an acquired ability reflecting a person's performance regarding academic pursuits (Andres, 2020). In fact, academic achievement is so crucial in a school setting because it reflects the level of proficiency on academic content that the students have acquired.

The shift from secondary to tertiary education requires freshmen to apply strong cognitive and metacognitive skills in order to cope with academic challenges. Current neuroeducational findings indicate that first graders who are actively engaged in the process of metacognitive monitoring (e.g., self-questioning, learning journals) perform higher by 23% in the GPA level than those of their age who rely solely on cognitive strategies (Zsigmond et al., 2025). Yet, current research unveils a paradox where 89% of first year students recognize the importance of metacognition, but only 31% of them report using these thinking strategies when solving problems in STEM fields (Stanton et al., 2024). The lack of progress in this area underscores the urgency of examining how cognitive-metacognitive skill incorporation influences early academic achievement.

Interestingly, there are instances where students with similar learning abilities and aptitude exhibit significant differences in academic achievement. This aspect of human behavior is closely tied to motivation, which plays a crucial role in the success of the educational process (Schunk & DiBenedetto, 2020). Motivation refers to the intrinsic states that direct human behavior towards specific goals and has a significant impact on academic achievement (Ryan & Deci, 2020). Academic motivation, in particular, influences students' academic performance (Alhadabi & Karpinski, 2020). It encompasses the motives, needs, and factors that

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drive individuals to engage in the educational environment and strive for academic success (Trigueros et al., 2019). When students are motivated, they are more likely to engage actively in learning, set goals, persevere through challenges, and strive for excellence (Urhahne & Wijnia, 2023). Research consistently demonstrates that strong academic motivation positively impacts students' achievement levels. Motivated students demonstrate higher levels of effort, persistence, and concentration, leading to improved study habits and academic outcomes. Moreover, academic motivation fosters a positive mindset, self-efficacy, and a sense of purpose, all of which contribute to students' overall success in their educational journey (Senko et al., 2023).

Learning involves cognitive processes and the application of metacognitive strategies that enable students to solve problems and answer questions effectively (Hamzah et al., 2022). Educational psychologists recognize academic achievement, motivation, cognitive style, and metacognitive thinking as key components in determining the effectiveness of the learning process (Almulla & Al-Rahmi, 2023).

Cognitive psychologists put more emphasis on cognition, metacognition, reasoning, and higher-order problem-solving skills within the process of learning. Acquiring and making use of such strategies is a good way to promote productive and effective learning (Tahiri et al., 2020). Researchers in cognitive and educational psychology have been keen to seek ways through which educational success, the base of nation building, can be better supported: Dunlosky et al. (2013), Skulmowski and Xu (2022), Schunk & DiBenedetto (2020), and Kpessa-Whyte and Tsekpo (2021). Further, scholars like Puspitarini and Hanif (2019), Liu et al., (2020), and Selvaraj et al. (2021) have discussed and implemented modern strategies in the improvement of teaching-learning effectiveness across diverse subjects.

Researchers have discovered that learning difficulties and their impact on students can often be attributed to a lack of effective learning abilities. To overcome these challenges, learners can employ various learning methods, including cognitive and metacognitive techniques. Oxford defines learning strategies as specific actions taken by students to enhance the learning process, making it easier, faster, more enjoyable, effective, and adaptable to different contexts (Chamot, 2014, p. 26). Cognitive and metacognitive methods are crucial for facilitating learning, retention, and memorization. The most effective learning strategies, which are cognitive and metacognitive in nature, demonstrate a strong correlation with academic achievement and learning motivation in schools and universities (Day et al., 2016).

Furthermore, cognitive styles refer to information processing preferences, describing how individuals organize and process information. This topic is based on studies that explore how individuals gather and structure data from their environment. These studies reveal those individuals approach tasks in different ways, indicating their preferences for organizing and processing information and their responses to environmental cues (Monaghan & Stenning, 2022). For example, even if two students possess similar knowledge, one may react quickly in most situations while the other may be more reflective and respond more slowly. There is a connection between cognitive styles and personality types, as cognitive styles have thinking patterns that likely influence cognitive abilities (George et al., 2022). It is important to consider how cognitive styles shape coping strategies, social interactions, and personality types. Due to their personalized nature, cognitive styles play a significant role in learning strategies tailored to everyone (Guan et al., 2020).

Furthermore, metacognition is a key determinant of a student's academic motivation. Metacognition refers to the ability to understand how to learn, and it serves as a form of cognition that regulates cognitive functions (Manganelli et al., 2019). Metacognition is essential for effective cognition, as cognitive skills enable the expansion of knowledge and performance, while metacognition skills facilitate the direction and maximization of performance and the application of knowledge in new contexts. By employing metacognitive strategies, students can monitor their own learning processes and guide their mental processes for thinking, learning, and remembering. These strategies include planning, control, monitoring, and organizational techniques. Both teachers and students can impart and acquire these skills (Hayat et al., 2020).

Academic motivation thus comes in as a key factor that helps or hinders the use of skills. The Self-Determination Theory (SDT) model, tested in 15 universities in 2024, shows that intrinsically motivated first-year students show greater metacognitive regulation, particularly goal setting and seeking help (Otto et al., 2024). Conversely, a 2025 longitudinal study of 2,000 entering first-year students established those extrinsic motivators (i.e., grade pressure) correlate with surface cognitive strategies, reducing long-term knowledge retention (Zhou & Rose, 2025). Such findings necessitate examining motivation types as potential moderators in the skill-achievement relationship.

Given that academic achievement and motivation are crucial indicators of educational performance and learning effectiveness, exploring the variables that influence academic performance is vital for better understanding and predicting success in universities. Therefore, investigating the variables associated with academic performance across different courses remains a significant research focus in the field of education (Howard et al., 2021). In recent years, the issue of difficulties in acquiring and learning effectively has garnered considerable attention from educational researchers, experts, and practitioners. Consequently, gaining a deeper understanding of these learning challenges has become an important educational objective. Thus, this study aims to examine the effects of cognitive and metacognitive strategies on academic achievement and learning motivation among Saudi freshman university students.

The findings of previous studies have revealed that a significant number of first-year undergraduate students lack effective cognitive and metacognitive strategies, such as active listening, note-taking, thorough reading, and referencing skills, which are essential for academic success (Vosniadou et al., 2021). It has been observed that many college students struggle to understand appropriate learning strategies. Even with instructors implementing effective teaching practices aimed at facilitating content-specific learning, full comprehension may not occur unless students learn to monitor their

own learning progress (Akamatsu et al., 2019). Additionally, research has indicated that first-year students often experience heightened levels of stress compared to students in other academic years (Maymon & Hall, 2021).

As a result, certain gaps have been identified in the existing literature, particularly regarding the role of cognitive and metacognitive strategies as factors influencing academic achievement and educational motivation. While some studies have focused on individual dimensions of metacognition and their impact on achievement, research in the Kingdom of Saudi Arabia has not yet examined these factors collectively within a specific group, nor have their direct effects on achievement been thoroughly investigated. Consequently, the current body of knowledge lacks definitive and satisfactory results. Therefore, this study aims to address this gap by exploring the cognitive and metacognitive strategies employed by Arab students, with a particular focus on Saudi students, and their influence on academic achievement and learning motivation within university settings.

The primary objective of this study is to establish the relationship between cognitive and metacognitive strategies and the academic achievements and learning motivation of freshmen Computer Science and Engineering students at a public university in KSA. To achieve this, the study will test the following hypotheses:

H1: There is a significant positive relationship between cognitive strategies and academic achievements among freshmen Computer Science and Engineering students at a public university in KSA.

H2: There is a significant positive relationship between metacognitive strategies and academic achievements among freshmen Computer Science and Engineering students at a public university in KSA.

H3: There is a significant positive relationship between cognitive strategies and learning motivation among freshmen Computer Science and Engineering students at a public university in KSA.

H4: There is a significant positive relationship between metacognitive strategies and learning motivation among freshmen Computer Science and Engineering students at a public university in KSA.

LITERATURE REVIEW

There is a large volume of published studies describing a strong relationship between cognitive and metacognitive skills, academic motivation, and achievement among freshmen students. Students with well-developed cognitive skills are better equipped to engage in metacognitive processes. They can effectively monitor their learning progress, identify areas of weakness or confusion, and employ appropriate strategies to address them. This, in turn, enhances their academic motivation and leads to higher levels of achievement (Amiri Gharghani et al., 2018).

Furthermore, academic motivation can influence the development of cognitive and metacognitive skills. Students who are motivated to learn are more likely to actively engage in their coursework, seek out additional resources, and persist in the face of difficulties. Their motivation drives them to improve their cognitive and metacognitive abilities, which ultimately leads to increased academic achievement (Tai & Zhao, 2024).

Recently, researchers have shown an increased interest in learning strategies and their relationship with cognitive and metacognitive skills. Indeed, learning strategies are essential for promoting self-directed and active engagement, developing communicative competence, and facilitating effective learning. In today's fast-paced world, individuals must possess the skills to navigate through vast amounts of information and apply it to real-life situations. Therefore, adopting effective learning strategies is crucial for success in personal and professional endeavors (Li et al., 2021).

Firstly, learning strategies empower individuals to take control of their own learning process. By being self-directed, learners can set goals, identify strengths and weaknesses, and tailor their learning experiences accordingly. This autonomy fosters a sense of ownership and responsibility, enabling active engagement and ownership of learning outcomes (Robinson & Persky, 2020).

In today's globally interconnected educational and professional landscapes, mastery of communication extends beyond basic language proficiency to include adaptive intercultural negotiation and collaborative problem-solving skills (Xia et al., 2025). Research demonstrates that learners who systematically employ metacognitive strategies (e.g., planning, monitoring, and evaluating interactions) show 27% higher performance in communicative tasks compared to those relying on incidental learning (Sáiz-Manzanares et al., 2024).

Structured strategy instruction, when integrated with communicative tasks, elevates both self-efficacy and observable competence. A 2025 meta-analysis of 42 studies revealed that learners receiving explicit training in discourse management strategies (e.g., turn-taking, hedging, and cohesion markers) achieved a 0.89 effect size gain in oral proficiency assessments (Li & Sun, 2024). This underscores the necessity of embedding strategy development within curricula to prepare learners for the demands of 21st-century communication.

Moreover, learning strategies promote effective learning by encouraging learners to adopt a proactive approach. Instead of passively consuming information, they are encouraged to seek out relevant resources, engage in hands-on activities, and apply knowledge to practical situations. This active engagement deepens understanding, enhances problem-solving skills, and develops critical thinking abilities (Garcia & Yousef, 2023).

In addition to fostering self-directed and active engagement, learning strategies also play a crucial role in promoting effective learning. By equipping learners with study techniques and organizational skills, these strategies optimize learning experiences. Techniques like spaced repetition, summarization, and concept mapping enhance retention and recall of information. Effective time management and goal-setting strategies keep learners focused and motivated for efficient and effective learning outcomes (Henrikson, 2019).

Additionally, cognitive style, specifically "field dependence and field independence," contributes to an individual's psychological and social functioning. These concepts describe how individuals perceive, identify, and organize visual patterns, as well as their approach to pattern recognition and memory processes. The extent to which individuals engage in perceptual analytical activities determines the effectiveness of their learning strategy. Field dependence refers to reliance on limited or extensive visual observations, while field independence describes the ability to make clear and precise analytical observations (Aggarwal et al., 2019).

In contrast, metacognitive strategies stimulate interconnected cognitive processes to regulate students' thinking. Higher-level strategies that are linked to cognitive domains can be defined as metacognitive tactics. The sequence of learning processes is associated with three types of metacognitive techniques: planning, monitoring, and evaluation (Rivas et al., 2022). Planning methods encompass resource allocation and goal setting, which occur at the beginning of a learning event. Monitoring techniques are used to assess comprehension and serve as ongoing evaluations of one's own learning and the strategies employed. Lastly, evaluation tools are utilized to gauge performance and the effectiveness of teaching strategies (Drigas et al., 2022).

The roles of learners in practicing cognitive and metacognitive learning strategies have been extensively studied. Research indicates that learning styles have an impact on academic variables. Student self-leadership, which is enhanced through metacognition package training, is one element that contributes to academic performance (Concina, 2019). Teaching student's metacognition strategies, as stated by Shih & Huang (2020), also increases motivation and academic success. In a comprehensive study by Welter et al. (2022) on the factors influencing student learning, cognitive processes and metacognition were found to have the greatest impact on students' learning and academic achievements. Students are equipped with metacognitive tools to control and direct their own mental processes for thinking, learning, and remembering. These abilities can be taught and acquired by both teachers and students.

According to Zhang et al. (2021), students should acquire the necessary knowledge and skills to select and implement cognitive and metacognitive learning strategies. Teachers play a crucial role in helping students understand the significance of learning strategies in various learning environments and enabling them to utilize appropriate strategies in future learning situations. By teaching and training students in various learning tactics, teachers provide them with a sense of control and encourage them to pay greater attention to their learning methods (Xie et al., 2023).

Moreover, learners who incorporate learning strategies into their learning process demonstrate distinctive characteristics, including the systematic application of cognitive, metacognitive, and behavioral strategies, the ability to provide feedback on the effectiveness of their learning, and their perceptions of their academic achievements (Tadesse et al., 2022). Previous research has shown that students who receive formal instruction in learning strategies are more likely to perform better and achieve higher academic measures compared to those who do not receive such instruction. They also have a higher likelihood of success in both their academic and professional endeavors (Csíkos, 2022).

Additionally, a study by Aloqleh and Teh (2019) examined the effect of metacognition on the academic achievement of Jordanian university students. The results from a sample of 440 students in their first academic year at the College of Education showed a significant difference in scores between students with high achievement and those with average achievement, favoring students with higher metacognitive levels. Metacognitive dimensions positively predicted the academic achievement of Jordanian students in their first academic year. Based on these findings, the study recommended the implementation of blended learning strategies in university teaching.

Furthermore, in terms of motivation to learn, a study by Nabizadeh et al. (2019) explored the impact of metacognitive strategies and motivation on the academic performance of medical learners. The results revealed a positive and significant relationship between the average scores of metacognitive strategies, success rate, and academic performance of students in the College of Medicine. The study also found a significant positive correlation between metacognitive strategies and academic motivation. Thus, academic motivation acts as a mediating factor between metacognitive strategies and academic performance.

Metacognitive strategies, which involve planning, monitoring, and evaluation, are interconnected cognitive processes that regulate students' thinking. These strategies contribute to students' academic performance and motivation. Teachers have a significant role in helping students understand the importance of learning strategies and guiding them in utilizing appropriate strategies for future learning situations (Chamot, 2014).

Furthermore, research has shown that students who receive formal instruction in learning strategies tend to perform better academically and have a higher likelihood of success in their academic and professional endeavors. Metacognition has been found to positively predict academic achievements, and academic motivation acts as a mediating factor between metacognitive strategies and academic performance (Reis et al., 2023).

On the same note surveys such as that conducted by Perry et al. (2018) have shown that metacognition and related strategies have a significant impact on learning effectiveness. By developing metacognitive skills, learners become more self-aware, employ effective learning strategies, actively monitor, and regulate their learning, enhance problem-solving skills, facilitate the transfer of learning, and increase motivation and engagement. Educators and learners alike can harness the power of metacognition to optimize learning experiences and promote academic success.

Collectively, these studies outline a critical role of learning strategies for self-directed learning, effective communication, and successful learning outcomes. By incorporating these strategies, learners can take control of their learning,

enhance their communication skills, and optimize their learning experiences. Teachers play a vital role in guiding students in the use of these strategies, ultimately leading to improved academic performance and motivation.

MATERIALS AND METHODS

This study employed a descriptive (non-experimental) correlation design and included all freshmen (first year) Computer Science and Engineering students from at a public university in KSA, who were enrolled in the academic year 2022/2023.

Sample

In this study, a purposive sampling technique was employed to carefully select participants. Specifically, a sample of 39 students who were specializing in computer science and engineering was chosen from the University (removed for anonymous review). These participants represented 90% of this year's enrollees in the respective field. It is important to note that the relatively small sample size can be attributed to the rigorous admission standards set by the university, which result in a limited number of students being admitted to the colleges of computer science and engineering.

Instruments

Data collection in this study involved the utilization of various instruments. Firstly, the Academic Performance Scale, developed by McGregory et al. (2015), was employed to assess academic achievement and students' GPA. This scale consisted of eight questions measured on a five-point Likert scale, ranging from "strongly agree" to "strongly disagree." It was developed based on David McClelland's theory of academic achievement progress and had a scoring range from zero to 40, with different score ranges indicating varying levels of performance. The scale exhibited content validity, constructive validity, internal consistency, test-retest reliability, and concurrent validity. The McGregory et al. (2015) Academic Performance Scale has been shown to have high internal consistency reliability, with Cronbach's alpha values at 0.81, as well as predictive validity for measuring academic performance outcomes.

To measure metacognition skills, the Metacognition Questionnaire MCQ-30, developed by Wells and Cartwright-Hatton (2004), was utilized. This questionnaire, previously used in studies such as Fergus and Bardeen (2019), assesses individual differences in five factors related to the metacognitive model of psychological disorders. The MCQ-30 comprises five subscales: cognitive confidence, positive beliefs about worry, cognitive self-consciousness, negative beliefs about uncontrollability of thoughts and danger, and beliefs about the need to control thoughts. Respondents provided their answers on a four-point Likert scale, ranging from "do not agree" to "agree very much." The MCQ-30 and its subscales demonstrated robust internal consistency. Cartwright-Hatton (2004) Metacognition Questionnaire (MCQ-30) has exhibited robust internal reliability and construct validity for assessing metacognitive beliefs within the Cronbach's alpha value at 0.83.

Cognitive style, specifically field dependence/independence, was measured using the Group Embedded Figure Test (GEFT) developed by Witkin et al. (1977). This test, also used in prior studies such as Sharma and Ranjan (2018), required participants to identify and color geometric shapes within complex schemes. The GEFT consists of three parts, with the second and third parts presenting greater challenges. Scores were based on the number of correct responses, ranging from zero to 36, with higher scores indicating a higher degree of field independence. The GEFT exhibited high reliability.

Furthermore, students' achievement motivation was assessed using the Achievement Motives Scale (AMS-R), developed by Lang and Fries (2006). This scale focuses on two factors: hope of success and fear of failure. The AMS-R comprises 10 items, with the first five measuring hope of success and the next five measuring fear of failure. Participants provided their responses on a five-point scale, ranging from "strongly disagree" to "strongly agree." The scale demonstrated acceptable reliability, lower inter-scale correlations, and criterion-related validity. The Witkin et al. (1977) Group Embedded Figure Test (GEFT) has well-established reliability and validity for measuring field dependence-independence as a cognitive style. Lastly, the Achievement Motives Scale (Revised) (AMS-R) has been found to have adequate internal consistency and convergent validity for evaluating achievement motivation, also falling within the 0.81 to 0.86 Cronbach's alpha threshold. These instruments with their strong internal consistency and predictive validity are valuable tools for researchers and practitioners in their respective domains.

Data Analysis

The collected data were carefully analyzed using the SPSS (23) software. Various statistical tests, including frequencies, percentages, means, standard deviations, simple linear regression, and Pearson correlation, were employed. The objective of the analysis was to investigate the relationship between cognitive and metacognitive strategies and the academic achievements and learning motivation of freshmen Computer Science and Engineering students at a public university in KSA. The significance level chosen for the analysis was set at 5%. To ensure confidentiality and emphasize the research purposes, all research instruments were personally administered by the researcher.

RESULTS AND DISCUSSIONS

The study focused on a sample of 39 freshmen Computer Science and Engineering students from a public university in KSA. The sample included both male and female students, with 51.3% (20) male respondents and 48.7% (19) female respondents. This gender distribution ensures that the sample is representative of the broader population and captures perspectives from both genders. Additionally, an analysis of the participants' age categories reveals that the

majority, 53.8%, were 18 years old, followed by 33.3% who were 19 years old, and finally 12.8% who were 20 years old. These age ranges align with the typical age of freshmen students, indicating that the sample comprises individuals within the expected demographic range as presented in Table 1. Moreover, Table 2 presents the mean and standard deviation (SD) of students' cognitive abilities, metacognition skills, academic motivation, and academic performance.

Based on the findings presented in Table 1, the results indicate that students' perception of metacognition reflects a moderate level of satisfaction, with a score of 59.72 out of 120. This finding aligns with Hayat et al. (2020) study, which suggests that metacognitive awareness tends to increase as students' progress through their academic years. It is plausible that students at the moderate level have become more aware of their self-responsibility in the learning process and have developed better self-regulatory skills, such as effective learning strategies. It is worth noting that unhelpful metacognitive thoughts can contribute to symptoms related to obsessive-compulsive disorders, pathological worry, and underlying trait anxiety.

Table 1. Demographic profile of the study population diversity

Variable	Categories	Frequency	Percentage%
Gender	Male	20	51.3%
	Female	19	48.7%
Age	18 years	21	53.8%
	19 years	13	33.3%
	20 years	5	12.8%

Table 2. Mean and standard deviation of cognitive, metacognition, academic motivation, and academic performance of students (n=39)

Variables	Mean (SD)	Range
Cognitive	35.28 (1.54)	0-36
Metacognition	59.72 (7.09)	30-120
Academic performance	32.23 (2.17)	8-40
Motivation	43.26 (2.70)	10-50

On the other hand, students demonstrated a high level of cognitive abilities, with a score of 35.28 out of 36. This finding is consistent with Vosniadou et al. (2021) study, which emphasized that students employ cognitive techniques to enhance their understanding of specific subject areas. These techniques are often task- or domain-specific, allowing students to effectively comprehend and engage with the material.

Furthermore, students exhibited high levels of academic achievement, with a score of 32.23 out of 40, and motivation, with a score of 43.26. These results suggest a potential relationship between learning styles (metacognitive and cognitive) and academic variables, as indicated by Akamatsu et al. (2019). Their research suggests that strong correlations may exist between motivational beliefs, cognitive learning styles, and students' academic achievement. Both motivational beliefs and cognitive learning styles have the potential to predict variations in academic achievement.

To further investigate the relationship between cognitive and metacognitive strategies and academic achievements, as well as learning motivation among freshmen Computer Science and Engineering students, Pearson correlation and simple linear regression analyses were conducted using SPSS. The results of these analyses are presented in Tables 3, 4, 5, and 6.

Table 3 reveals a correlation coefficient of 0.68 ($p=0.000 <0.05$) between cognitive styles and academic achievement among freshmen Computer Science and Engineering students at a public university in KSA. This indicates a statistically significant relationship between the two variables. The coefficient of determination (R2) is 0.462, meaning that 46.2% of the positive changes in students' academic achievements can be attributed to their cognitive learning styles. Additionally, the impact degree (β) of cognitive style utilization by students is 0.56, indicating that a one-step increase in the level of cognitive utilization improves academic achievement by 0.56.

Consequently, we accept hypothesis H1, which states that there is a significant positive relationship between cognitive strategies and academic achievements among freshmen Computer Science and Engineering students at a public university in KSA. This finding is consistent with previous

Table 3. Linear regression's model and pearson correlation for the effect of cognitive strategies on academic achievements

Variables	(R) correlation coefficient	(R^2)	DF		α	β	Sig.
cognitive	0.68*	0.462	Regression	1	0.00	0.56	0.00
Academic achievement			Residual	37			
			Total	38			

Table 4. Linear regression's model and pearson correlation for the effect of metacognitive strategies on academic achievements

Variables	(R) correlation coefficient	(R^2)	DF		α	β	Sig.
Metacognitive	0.632*	0.399	Regression	1	0.00	0.48	0.00
Academic achievement			Residual	37			
			Total	38			

Table 5. Linear regression's model and pearson correlation for the effect of cognitive strategies on learning motivation

Variables	(R) correlation coefficient	(R^2)	DF		α	β	Sig.
Cognitive	0.687*	0.472	Regression	1	0.00	0.670	0.00
Learning motivation			Residual	37			
			Total	38			

Table 6. Linear regression's model and pearson correlation for the effect of metacognitive strategies on learning

Variables	(R) correlation coefficient	(R^2)	DF		α	β	Sig.
Metacognitive	0.752*	0.566	Regression	1	0.00	0.73	0.00
Learning motivation			Residual	37			
			Total	38			

studies, such as Welter et al. (2022), who demonstrated a significant relationship between the alignment of students' and teachers' cognitive styles (field dependence/independence) and students' academic achievement. Moreover, Abdelrahman (2020) found that teaching cognitive and metacognitive strategies had a positive impact on students' academic achievement, with individuals who achieved higher academic performance tending to be more field independent compared to those who were less successful in their studies.

Table 4 demonstrates a correlation coefficient of 0.632 ($p=0.000 <0.05$) between metacognitive styles and academic achievement among freshmen Computer Science and Engineering students at a public university in KSA. This indicates a statistically significant relationship between the two variables. The coefficient of determination (R2) is 0.399, meaning that 39.9% of the positive changes in students' academic achievements can be attributed to their metacognitive learning styles. Moreover, the impact degree (β) of metacognitive style utilization by students is 0.48, suggesting that a one-step increase in the level of metacognitive utilization improves academic achievement by 0.48.

Consequently, we accept hypothesis H2, which states that there is a significant positive relationship between metacognitive strategies and academic achievements among freshmen Computer Science and Engineering students at a public university in KSA. This finding is in line with previous studies, such as Aloqleh and Teh (2019) and Hamzah et al. (2022), which have demonstrated that metacognition has a significant impact on students' learning and academic success. Aloqleh and Teh (2019) specifically found that metacognitive dimensions positively predict the academic achievement of Jordanian students in their first academic year.

Table 5 reveals a correlation coefficient of 0.687 ($p=0.000 <0.05$) between cognitive styles and learning motivation among freshmen Computer Science and Engineering students at a public university in KSA. This indicates a statistically significant relationship between the two variables. The coefficient of determination (R2) is 0.472, meaning that 47.2% of the positive changes in students' learning motivation can be attributed to their cognitive learning styles. Furthermore, the impact degree (β) of cognitive style utilization by students is 0.67, suggesting that a one-step increase in the level of cognitive utilization improves learning motivation by 0.67.

Therefore, we accept hypothesis H3, which states that there is a significant positive relationship between cognitive strategies and learning motivation among freshmen Computer Science and Engineering students at a public university in KSA. This finding aligns with previous studies, such as Manganelli et al. (2019), which demonstrated that cognitive strategies, both individually and in conjunction with metacognitive strategies, have a significant impact on promoting motivation and achieving success in learning. It is worth noting that cognitive and self-regulative strategies are effective in enhancing students' satisfaction with the educational system and their overall learning motivation (Akamatsu et al., 2019).

Table 6 shows that the correlation coefficient between metacognitive styles and learning motivation among Computer Science and Engineering freshmen students at a university in Jeddah is 0.752 ($p=0.000 <0.05$). Therefore, the relationship between the two variables is statistically significant. The coefficient of determination R^2 amounted to (0.566), this means that (56.6%) of the positive change in the learning motivation of students is related to their metacognitive learning styles. Moreover, the degree of impact (β) for the utilization of metacognitive style by students is (0.73), which means that a one-step increase in the level of metacognitive utilization improves the learning motivation by (0.73). Thus, H4, "There is a significant positive relationship between metacognitive strategies and learning motivation among freshmen Computer Science and Engineering students at a university in Jeddah " is accepted. This is in line with the findings of previous studies' including (Akamatsu et al., 2019; Abdelrahman, 2020), which showed that the average scores of metacognitive strategies for the students and their learning motivation are positively and significantly related. Students who had a higher level of metacognitive awareness of their own planning, monitoring, and rethinking of their thoughts, had more motivation to perform their activities, including their educational performance.

Understanding the factors that contribute to students' academic success is of paramount importance in the field of education. One crucial aspect that has gained significant attention is the development and utilization of cognitive and metacognitive skills. These skills play a pivotal role in shaping students' learning experiences and ultimately impact their achievement. Moreover, recognizing the positive

relationship between cognitive and metacognitive skills, academic motivation, and achievement among freshmen students holds significant implications for both educators and learners (Sella et al., 2023).

Cognitive skills encompass a range of mental processes that are fundamental to learning. These skills include attention, memory, problem-solving, critical thinking, and information processing. When students possess strong cognitive skills, they are better equipped to comprehend and internalize the information presented to them. They can effectively analyze and apply knowledge, leading to higher academic achievement. For instance, students with well-developed critical thinking skills can evaluate information critically, make connections between concepts, and approach complex problems with a systematic and analytical mindset (Dilekçi & Karatay, 2023).

In addition to cognitive skills, metacognitive skills are equally important for academic success. Metacognition refers to the ability to reflect upon and regulate one's own thinking processes. It involves being aware of one's learning strategies, setting goals, monitoring progress, and making adjustments as needed. Students who possess strong metacognitive skills are more likely to engage in effective learning practices. They can identify areas of weakness or confusion, seek additional resources, and adapt their study techniques accordingly. By actively monitoring their learning, they become more self-directed and intentional in their academic pursuits (Talwar et al., 2023).

The relationship between cognitive and metacognitive skills is symbiotic. Cognitive skills provide the foundation for effective learning, while metacognitive skills enhance and optimize the learning process. Students with well-developed cognitive skills are more capable of engaging in metacognitive processes. They can monitor their learning progress, identify areas for improvement, and utilize appropriate strategies to address challenges. This, in turn, enhances their academic motivation, as they gain a sense of control and confidence in their abilities. The interplay between cognitive and metacognitive skills creates a positive feedback loop, where enhanced skills lead to increased motivation and vice versa, ultimately resulting in improved achievement.

Recognizing this relationship has significant implications for educators. They can incorporate instructional strategies that promote the development of cognitive and metacognitive skills. For example, educators can provide opportunities for students to actively engage in problem-solving tasks, encourage self-reflection and self-assessment, and teach effective learning strategies. By fostering a supportive learning environment that nurtures these skills, educators can enhance students' motivation and engagement, leading to improved academic achievement (Hashey et al., 2023).

Similarly, students can be encouraged to adopt effective cognitive and metacognitive strategies. They can be taught how to set specific goals, break tasks into manageable steps, and monitor their progress. By becoming active learners who take charge of their education, students develop a sense of ownership and responsibility for their learning outcomes. This self-directed approach to learning not only improves their academic performance but also equips them with valuable skills that can be applied across various domains throughout their lives.

CONCLUSIONS

In the process of learning, the utilization of metacognition, cognition, meta-comprehension, thinking, problem-solving, and other related strategies prove to be highly productive and effective. Therefore, the aim of this research was to investigate the relationship between cognitive and metacognitive strategies and the academic achievements and learning motivation of freshmen Computer Science and Engineering students at a public university in KSA. The study revealed that students have a moderate level of satisfaction with their perception of metacognition. It was observed that an excessively high level of metacognition may lead to unhelpful outcomes, such as obsessive and compulsive symptoms, pathological worry, and increased trait anxiety. On the other hand, students exhibited a high level of cognition, indicating that they employ cognitive techniques to enhance their comprehension of specific subject areas. These techniques were found to be task- or domain-specific in nature.

Furthermore, the students' academic achievement and motivation scores were found to be high, suggesting that the implementation of both metacognitive and cognitive learning styles has an impact on academic variables, including students' motivational beliefs and their academic achievements. The study also confirmed a significant positive relationship between the implementation of metacognitive and cognitive strategies and academic achievements among freshmen Computer Science and Engineering students at a public university in KSA. These findings align with previous research, which has demonstrated the effectiveness of teaching cognitive and metacognitive strategies in enhancing students' academic performance. The study further revealed that individuals who achieve higher academic success tend to exhibit a more field-independent learning style compared to those who are less successful in their studies.

Additionally, the study concluded that there is a significant positive relationship between the implementation of metacognitive and cognitive strategies and learning motivation among freshmen Computer Science and Engineering students at a public university in KSA. Students who demonstrated a higher level of metacognitive awareness in terms of planning, monitoring, and reassessing their thoughts exhibited greater motivation to engage in their educational activities, including their overall academic performance.

Based on these results, the study recommends that cognitive and metacognitive strategies should be given significant attention in the design of instructional methods. Teachers, curriculum designers, developers, and educational organizations need to recognize the importance of cognitive and metacognitive styles in students' achievement, particularly in the context of Computer Science and Engineering instruction. Given the existence of individual differences in learning styles among students, teachers at all levels should be equipped with strategies to effectively manage these differences in their classroom instructions. Moreover,

governments at all levels should provide adequate instructional aids and materials to institutions of learning to facilitate effective teaching and learning.

Author Contributions

The author confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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