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Exploring the Impact of Cognitive Factors on Learning, Motivation and Career in Malaysia's STEM Education

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Abstract
Advancements in science, technology, engineering, and mathematics (STEM) are critical to the success of modern societies. However, STEM education and careers are often hindered by cognitive factors, such as mindset, motivation, and learning strategies. This paper examines the complex interplay between cognitive factors and STEM education and careers, highlighting the profound influence of these factors on success in these fields. Through a comprehensive review of existing literature and empirical evidence, this paper presents a compelling case for the need to prioritize cognitive development in STEM education and career pathways. We argue that by fostering a growth mindset, cultivating intrinsic motivation, and promoting effective learning strategies, individuals can overcome cognitive barriers and achieve success in STEM education and careers. Ultimately, this paper underscores the critical role of cognitive factors in shaping the future of STEM fields and offers practical recommendations for educators, policymakers, and STEM professionals to support cognitive development and enhance STEM outcomes.
Keyword: Cognitive, STEM Education, Career, Learning Style, Motivation

Introduction

In the pursuit of optimizing educational outcomes, researchers and educators have turned their attention to the role of cognition as a critical factor influencing learning styles, motivation, and the field of STEM education. Cognitive processes, including perception, attention, memory, and problem-solving, shape how individuals perceive, process, and retain information. Understanding how these cognitive factors interact with learning styles and motivation is key to designing effective educational interventions that foster academic achievement and engagement in STEM fields. According to a recent study by Idris et al (2023), the current state of STEM education in Malaysia is confronted with significant challenges and obstacles in terms of fostering student enrolment in STEM courses at schools.

Numerous studies have delved into the relationship between cognition and learning styles, shedding light on the individual differences in information processing that impact how learners acquire and assimilate knowledge (Riding & Rayner, 1998). Cognitive styles, such as field dependence/independence or holistic/analytic thinking, influence how learners approach tasks and organize information (Witkin et al., 1977). For instance, individuals with a holistic cognitive style tend to focus on the bigger picture, while those with an analytic style prefer to break down information into smaller components. These cognitive styles have implications for instructional strategies and the design of learning materials to match the learners' cognitive preferences (Sadler-Smith & Riding, 1999).

Moreover, motivation, a key driver of learning, is intimately linked to cognitive factors. Individuals are more likely to be intrinsically motivated when they perceive a sense of autonomy, competence, and relatedness in their learning experiences, according to cognitive evaluation theory (Deci & Ryan, 1985). Cognition plays a crucial role in shaping these perceptions, as learners' beliefs about their abilities, self-efficacy, and attributions for success or failure impact their motivation to engage in learning tasks (Dweck, 2000; Pintrich & Groot, 1990).

Understanding the cognitive bases of learning styles and motivation is especially important in STEM education. The complex and abstract nature of STEM subjects demands cognitive processes such as critical thinking, problem-solving, and conceptual understanding (Hofstein & Rosenfeld, 1996). Research has shown that cognitive factors, including spatial ability, working memory capacity, and cognitive flexibility, are associated with STEM achievement and career aspirations (Hegarty et al., 2010; Stoet & Geary, 2013).

The importance of empowering cognitive skills in STEM education in Malaysia lies in fostering higher-order thinking skills, creativity, and intelligence in the fields of science, technology, engineering, and mathematics. These are essential for the development of an advanced and innovative nation. Idris and Bacotang (2023) highlight the importance of assisting and empowering students to increase their enrolment in STEM fields and careers, not only for economic development but also to meet the demands of Industrial 4.0 and Society 5.0.

By recognizing the impact of cognitive factors on learning styles, motivation, and STEM education, educators and policymakers can design instructional strategies, interventions, and curricula that cater to individual differences and foster optimal learning environments. This article aims to synthesize existing research, provide empirical evidence, and offer insights into the practical implications of cognitive factors for enhancing educational practices and promoting student success in STEM fields.

Cognitive in Learning Style

Learning styles are a person's preferred technique of collecting and processing knowledge, and they can have a substantial impact on academic accomplishment (Ilcin et al., 2018). While learning styles have garnered a lot of attention, the significance of cognitive processes in determining individual differences in learning styles has gotten less (Kozhevnikov et al., 2014). Cognitive factors, including attention, memory, perception, and reasoning, interact with learning styles to influence the way individuals learn and retain information (Husmann & O'Loughlin, 2019). Understanding the complex interplay between cognitive factors and learning styles is essential for designing effective instructional methods and supporting learners with diverse needs.

Within the intricate realm of learning preferences, cognitive factors assume a paramount role, shaping the unique pathways individuals traverse in their pursuit of knowledge and illuminating the profound interplay between cognition and personalized learning experiences. Cognitive style describes how learner process and think (LeBlanc, 2018). Cognitive style may influence individuals' preference for different learning methods and activities (Sadler-Smith et al., 2000).

The relationship between cognitive factor and learning is significance as cognitive factors such as metacognition and self-regulated learning strategies play a critical role in shaping how individual approach and process information in their learning environment. Shi (2011) Cognitive type has a substantial impact on learners' selection of learning techniques. In an e-learning situation, adapting learning content to cognitive style was critical (Palo et al., 2012).

In training design, the dynamic interplay of cognitive style and learning style offers invaluable implications, facilitating the customization of instructional strategies to unleash individuals' learning potential and create optimal learning experiences. Theoretical and empirical underpinnings for acknowledging the essential role of cognitive style in determining learning performance appear to be lacking in conventional training design methodology (Sadler-Smith & Riding, 1999). Individual and organisational behaviour are influenced by cognitive style, which manifests itself in individual workplace activities as well as organisational structures, procedures, and routines (Sadler-Smith & Badger, 1998).

Unveiling the untapped potential within the realm of learning style, harnessing the remarkable cognitive traits serves as the transcendent key, unlocking a treasury of transformative pedagogical possibilities, catalyzing a symphony of personalized education that propels learners towards boundless growth and unparalleled academic mastery. The consideration of cognitive traits can help in detecting learning styles (Graf-Kinshuk, 2010). The use of style differences for lifelong learning in both education and the workplace is being investigated (Rayner, 2015).

Other than that, the profound interplay between cognitive style and academic achievement unveils the extraordinary potential of embracing individual cognitive strengths, unlocking a symphony of intellectual prowess that orchestrates unparalleled academic excellence. Academic achievement was highly influenced by cognitive style and learning practises (Tinajero et al., 2012).

At the core of the acquisition of cognitive skill, cognitive factors assume a pivotal role, orchestrating the intricate dance between knowledge acquisition, information processing, and strategic application, ultimately paving the way to mastery and expertise. Cognitive style can affect the efficacy of initiatives aimed at improving individual and organisational performance (Hayes & Allinson, 1998). On the other hand, cognitive style had significant mode on learning style (Yasmeen et al., 2020).

In the dynamic landscape of organizations, embracing the diverse cognitive styles and harnessing the power of cognitive theories for individual and collective learning becomes an indispensable catalyst, propelling innovation, adaptability, and growth. Interventions aiming to promote individual and organisational performance can benefit from cognitive style (Hayes & Allinson, 1998). The link between learning styles and cognitive features can help to improve student modelling accuracy (Graf et al., 2008).

This study analyses the tremendous effect of cognitive style and learning style on the academic accomplishment of primary school kids, showing the subtle linkages between individual cognitive and learning preferences and their later educational results. The learner having field dependents and field independents have different learning styles (Kumar et al, 2017). Fields dependence-field independence refers to the relatively persuasive manner in which individual learners absorb, structure, and analyse information (Pithers, 2002).

In the realm of higher education, the significance of cognitive and learning style becomes evident as they intricately shape the learning processes, instructional approaches, and academic experiences of students, ultimately influencing their engagement, success, and personal growth within the complex landscape of higher learning. The European Learning Styles Information Network is expanding knowledge of cognitive and learning styles theory and application in higher education and other settings (Evans et al., 2010).

By cultivating a deep awareness of students' learning styles, educators lay a solid foundation for the development of effective teaching and learning strategies, unlocking the potential to create engaging and impactful educational experiences that resonate with the diverse needs and preferences of individual learners. On the one hand, the psychological traits necessary for the establishment of cognitive learning methods are a time orientation, a demand for cognition, and autonomy (Kostomina & Dvornikova, 2016). Educators must be prepared to accommodate all learning styles (Ros et al., 2016).

Table 1
The Influence of Cognitive Factor on Learning Styles

Researcher	**Results**
Ilcin et al (2018)	Learning styles have a significant impact on academic achievement.
Kozhevnikov et al (2014); Husmann & O'Loughlin (2019)	Cognitive processes interact with learning styles to influence preferences and approaches to learning.
LeBlanc (2018); Sadler-Smith et al (2000)	Cognitive style influences how learners process information and their preferences for learning methods and activities.
Shi (2011); Palo et al (2012)	Cognitive factors, such as cognitive type, impact learners' selection and adaptation of learning techniques.
Sadler-Smith & Riding (1999); Sadler-Smith & Badger (1998)	Cognitive style plays a crucial role in determining learning performance and influences individual and organizational behavior.

Graf-Kinshuk (2010); Rayner (2015)	Cognitive traits can help detect and investigate learning styles for lifelong learning.
Tinajero et al (2012)	Cognitive style and learning practices strongly influence academic achievement.
Hayes & Allinson (1998); Yasmeen et al (2020)	Cognitive style significantly affects learning style and the efficacy of performance improvement initiatives.
Graf et al (2008)	Linking learning styles to cognitive features improves student modeling accuracy.
Kumar et al (2017); Pithers (2002)	Field dependence-field independence impacts learning styles and the way individuals absorb, structure, and analyze information.
Evans et al (2010)	Cognitive and learning styles theory and application are relevant in higher education.
Kostomina & Dvornikova (2016); Ros et al (2016)	Psychological traits, such as time orientation, demand for cognition, and autonomy, are necessary for cognitive learning methods, and educators need to accommodate all learning styles.

Cognitive as Motivation Factors

Student motivation is a complicated phenomenon that is influenced by a number of factors, including cognitive qualities such as self-regulation, learning tactics, and mentality. These cognitive factors play a critical role in shaping students' beliefs about their own ability to succeed, their goals for learning, and their approach to academic tasks (Dweck, 2006). Understanding the relationship between cognitive factors and student motivation is essential for educators who seek to promote engaged and successful learners. The mechanisms that initiate and sustain goal-directed conduct are defined as motivation (Schunk & DiBenedetto, 2020).

Motivation serves as a crucial factor in fostering and sustaining individuals' interest in STEM fields, as intrinsic motivation, driven by personal curiosity, passion, and the sense of purpose, plays a pivotal role in nurturing long-term engagement and pursuing careers in science, technology, engineering, and mathematics. Even after controlling for socioeconomic position, STEM career awareness, and science achievement, motivational factors remain major predictors of STEM career aspirations (Ahmed & Mudrey, 2018). The key determinant of students career intentions were interest (Hatisaru, 2021).

Social cognitive factors, such as observing role models, receiving support and encouragement from peers and mentors, and perceiving a sense of belonging in STEM communities, significantly influence individuals' motivation to pursue STEM fields, highlighting the importance of social context in shaping career aspirations and sustained engagement. Key motivational processes include goals and self-evaluations of progress, outcome expectancies, values, social comparisons, and self-efficacy (Schunk & DiBenedetto, 2020). In both processing and attitudes, accuracy was successfully paired with directional motivation (Lundgren & Prislin, 1998).

The dynamic relationship between cognition and motivation forms the bedrock of an interdisciplinary perspective, weaving together insights from psychology, neuroscience, and education to unravel the intricate connections between how our minds work and what drives our actions and aspirations. The contributions go beyond the traditional technique of investigating the effect of motivation and emotion by taking into account the contextual elements that may influence cognition (Kreitler, 2013). Motivation can influence reasoning by relying on a biassed collection of cognitive processes (Kunda, 1990).

Exploring the energetics of motivated cognition unveils the fascinating interplay between cognitive processes and the allocation of mental resources, shedding light on how our motivational states influence the efficiency, focus, and persistence of our thinking and problem-solving abilities. It is considered that purposeful cognitive activity is propelled by a driving force and resisted by a restraining force (Kruglanski et al., 2012). Motivational strength is greatest when the sum of people's expectations for and value of goal achievement is greatest (Spiegel et al., 2004).

Motivational and cognitive factors serve as powerful predictors of goal setting and task performance, as individuals' intrinsic motivation, goal orientation, and cognitive abilities intricately shape their goal-setting strategies, self-regulation, and ultimately, their level of achievement and success in various tasks and endeavors. Goal attainment seems to be influenced by both task-related abilities and motivational attitudes (Niemivirta, 1999). Achievement-based incentives increased participants' intrinsic motivation throughout learning or testing (Cameron et al., 2005).

Social cognitive factors, including peer observation, feedback, and a sense of belonging, strongly influence motivation in relation to learning style. Cognitive learning procedures have a time orientation, a demand for cognition, and autonomy as psychological characteristics (Kostromina & Dvornikova, 2016). Affective experience can influence these behavioural consequences indirectly by changing goal level and goal commitment (Seo et al., 2004).
Furthermore, the cognitive basis of students' motivation contributes to their psychological stability, as their beliefs about their own abilities, their sense of self-efficacy, and their attributions for success or failure impact their motivation levels and overall well-being in educational contexts. The relationship between students' achievement incentives and cognitive interest in general mechanisms of mental regulation of training and education enables a teacher to determine the reference point of psychological training and education regulation (Kozhan & Tapalova, 2020).

The cognitive approach to motivation in individuals with intellectual disabilities emphasizes understanding their unique cognitive processes, such as perception, memory, and problem-solving, in order to develop tailored strategies and interventions that promote motivation and engagement in various aspects of their lives, including learning and personal development. Cognitive orientation measures may be expected to help identify those individuals who may benefit most or minimal from available programs, services or training (Kreitler & Kreitler, 1988). The prospect of engaging in intellectual work appears to create different motivations in those with high and low cognition needs (Steinhart & Wyer, 2009).

Critical thinking abilities, problem-solving skills, and cognitive flexibility are all linked to higher education students' engagement and success in STEM education, as these cognitive abilities are required for navigating the complex challenges and conceptual demands of STEM disciplines. Key motivational processes include goals and self-evaluations of progress, outcome expectancies, values, social comparisons, and self-efficacy (Schunk & Usher, 2012). The motivation for cognition scale is valid measure of momentary cognitive motivation (Blaise et al., 2021).

Table 2
The Relationship Between Cognitive and Motivation

Researcher	**Results**
Dweck (2006)	Cognitive factors play a critical role in shaping students' beliefs and approach to academic tasks.
Ahmed & Mudrey (2018); Hatisaru (2021)	Intrinsic motivation driven by personal curiosity and passion fosters long-term engagement in STEM fields.
Schunk & DiBenedetto (2020); Lundgren & Prislin (1998);	Social cognitive factors, such as role models and sense of belonging, significantly influence motivation in STEM.
Kreitler (2013); Kunda (1990)	The dynamic relationship between cognition and motivation shapes our thinking and problem-solving abilities.
Niemivirta (1999); Cameron et al (2005)	Motivational and cognitive factors predict goal setting and task performance.
Kostromina & Dvornikova (2016); Seo et al (2004)	Social cognitive factors strongly influence motivation in relation to learning style.
Kozhan & Tapalova (2020)	Cognitive processes impact motivation levels and overall well-being in educational contexts.
Kreitler & Kreitler (1988); Steinhart & Wyer (2009)	Understanding cognitive processes of individuals with intellectual disabilities helps develop tailored interventions.
Schunk & Usher (2012); Blaise et al (2021)	Critical thinking and problem-solving abilities are linked to engagement and success in STEM education.

Cognitive Factor in STEM Education

STEM (science, technology, engineering, and mathematics) education is becoming increasingly vital in today's society, as these subjects are critical in generating innovation, economic growth, and worldwide competitiveness. However, the success of STEM education is not solely dependent on students' knowledge of these subjects; cognitive factors such as problem-solving skills, creativity, and metacognition are also crucial for success in STEM fields (National Academy of Engineering, 2014). According to research, students with high cognitive skills are more likely to succeed in STEM education and careers.

The influence of cognitive factors extends beyond academic achievement, shaping individuals' interest and occupational choices in STEM fields, as cognitive abilities such as spatial reasoning, problem-solving, and analytical thinking are closely linked to engagement and success in STEM disciplines. STEM career interest and goal perseverance model predicted by social-cognitive career theory for minority college students with disabilities (Dutta et al., 2015). STEM occupations are more likely to be chosen by those with asymmetrical cognitive ability profiles (Wang et al., 2016).

Harnessing the power of technology, the integration of learning style and cognitive trait identification within a learning management system unveils a transformative landscape where personalized instruction, tailored resources, and adaptive learning experiences converge, empowering learners to embark on a journey of self-discovery and optimal educational growth. A learning management system can estimate a learner's learning style and cognitive attributes (Lwande et al., 2021). STEM-based education has the potential to boost the cognitive skills of primary school kids (Firdaus & Rahayu, 2019).

The cognitive movement in education galvanizes a paradigm shift, emphasizing the profound impact of cognitive processes and metacognitive strategies on learning outcomes, paving the way for innovative instructional approaches that cultivate higher-order thinking, self-regulation, and lifelong intellectual growth. The cognitive influence is finding its way into the teaching of specific subjects (Di Vesta, 1987).

Students endowed with cognitive abilities well-suited for STEM education possess a remarkable advantage, as their innate aptitude for analytical thinking, problem-solving, and critical reasoning paves the way for a fruitful journey of exploration, discovery, and success in the dynamic world of STEM disciplines. STEM education promotes higher-order thinking and cognitive skill levels (Zeng et al., 2018). Students who got support from their teachers and parents were more likely to develop positive views towards future postsecondary education and job paths in STEM subjects (Rivera & Li, 2020).

Cognitive science research holds the potential to revolutionize undergraduate STEM instruction, infusing evidence-based practices and innovative strategies that enhance conceptual understanding, critical thinking, and ignite a profound love for scientific exploration among students. The lack of contact between cognitive science and STEM discipline-based education research researchers delays the adoption of cognitive science discoveries in undergraduate STEM education (Henderson et al., 2015).

The seamless integration of cognitive science principles and cutting-edge technology brings forth a remarkable transformation in the STEM classroom, propelling learning to new horizons by optimizing instructional strategies, enhancing student engagement, and fostering deeper conceptual understanding and mastery of complex scientific concepts. Implementing three simple, powerful principles from cognitive science improved learning in a college engineering course (Butler et al., 2014).

Furthermore, cognitive apprenticeship serves as a transformative framework in STEM graduate education, immersing students in authentic disciplinary practices, fostering expert-guided mentorship, and cultivating the cognitive skills and knowledge necessary for professional success in the complex and rapidly evolving landscape of STEM disciplines. The cognitive apprenticeship framework is a valuable and effective strategy for assisting STEM graduate instructors (Minshew et al., 2021).

STEM education serves as a catalyst for boosting brain activity in preschool-age children, nourishing their curiosity, developing critical thinking abilities, and sparking a lifetime interest in the wonders of science, technology, engineering, and mathematics. Practical experiments are designed to increase preschool through elementary school students' interest in science, technology, engineering, and mathematics (Ros et al., 2016).

Addressing challenges and issues is crucial in empowering elementary preschool students to develop an interest in STEM education, fostering inclusive environments, integrating hands-on experiences, and ensuring equitable access to resources for an engaging and equitable learning experience. STEM education should be encouraged beginning in childhood so that youngsters enjoy it and pursue it further in their education (Qureshi & Qureshi, 2021). STEM achievement in high school is more important for college enrollment than STEM-positive views among kids with most disability categories (Shifrer & Freeman, 2021).

Embodied cognition intertwines with STEM learning, illuminating the profound connection between the mind and body, as students actively engage in hands-on experiences, immersive simulations, and physical interactions, fostering a deeper understanding of abstract concepts and nurturing a holistic approach to problem-solving within the realms of science, technology, engineering, and mathematics. Approaches to embodied learning emphasise the use of activity to promote pedagogical goals (Weisberg & Newcombe, 2017).
Long-term intervention in integrated STEM education exerts a transformative effect on students' cognitive performance, fostering enhanced problem-solving skills, critical thinking abilities, and interdisciplinary knowledge essential for success in the 21st century. Integrated STEM education improved cognitive performance in terms of mathematics understanding and application, as well as technical concepts (De Loof et al., 2022). Students who participated in more STEM PBL projects and STEM summer camps are more likely to pursue STEM majors in college (Sahin et al., 2017).

We highlight the ways in which cognitive factors support student learning in STEM subjects, and present practical strategies for educators to promote the development of these factors in their students. By exploring the complex interplay between cognitive factors and STEM education, the purpose of this study is to contribute to a better understanding of how to develop effective STEM learners and professionals.

Conclusion and Future Agenda

In conclusion, the impact of cognitive characteristics on learning styles, motivation, and STEM education has been widely documented. According to research, learning styles have a substantial impact on academic accomplishment, and cognitive processes interact with learning styles to shape preferences and learning approaches. Cognitive characteristics such as cognitive type and cognitive style influence how learners choose and adapt learning approaches.

Furthermore, cognitive factors influence students' attitudes, approach to academic activities, and motivation levels. Cognitive qualities such as problem-solving skills, creativity, and metacognition are critical for success in STEM education, and students with strong cognitive skills are more likely to flourish in STEM disciplines. When learning style and cognitive trait detection are combined within a learning management system, personalised instruction and adaptive learning experiences are provided.

The cognitive movement in education emphasises the fundamental impact of cognitive processes on learning outcomes, paving the door for novel instructional approaches that foster higher-order thinking and lifelong intellectual progress. Undergraduate STEM training can be revolutionised by leveraging cognitive science research and using evidence-based practises to improve conceptual understanding and critical thinking. In STEM classrooms, the seamless integration of cognitive science principles and technology optimises instructional methodologies and develops deeper conceptual understanding.

Furthermore, cognitive apprenticeship is a transformative framework in STEM graduate education, building cognitive abilities and knowledge required for professional success. STEM education fosters curiosity, critical thinking skills, and a lifetime interest in science, technology, engineering, and mathematics from an early age. Identifying and addressing issues, as well as ensuring equal access to resources, are critical in developing an engaging and inclusive STEM learning experience.

In STEM fields, embodied cognition and hands-on experiences improve students' grasp of abstract concepts and foster holistic problem-solving. Long-term interventions in integrated STEM education boost cognitive performance, problem-solving skills, critical thinking abilities, and interdisciplinary knowledge, all of which are required for success in the twenty-first century.

These include creating a supportive and challenging learning environment, providing opportunities for hands-on, inquiry-based learning, encouraging students to reflect on their learning processes, and promoting a growth mindset that emphasizes the importance of effort and persistence. By prioritizing the development of cognitive factors in STEM education and career pathways, we can help to ensure that the next generation of innovators and problem-solvers are equipped with the skills and mindset needed to tackle the complex challenges of our rapidly changing world.

Overall, the literature suggests that cognitive factors are critical to success in STEM education and careers, and that educators and other stakeholders should prioritize the development of these factors in their students. By doing so, we can help to create a more inclusive, equitable, and innovative STEM workforce that is better equipped to address the challenges and opportunities of the 21st century.

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