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STEM Learning Model's Impact on Enhancing Critical Thinking Skills and Motivation: A Literature Review

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Abstract

The rapid pace of societal advancement necessitates a robust educational foundation to ensure individuals can effectively navigate and contribute to contemporary developments with their skill sets. Education plays a pivotal role in human development, influenced by a range of internal and external factors, all of which are crucial considerations for optimizing the human development process. Quality education is characterized by its ability to impart critical thinking skills and foster a motivation to learn among its students. STEM (Science, Technology, Engineering, and Mathematics) represents a pedagogical model that supports the cultivation of these skills and motivations. By integrating multiple disciplines into a cohesive framework, STEM aims to produce graduates who are competent and equipped for the challenges of the modern world. This literature review provides a systematic examination and discussion of the theoretical and conceptual underpinnings of STEM, critical thinking skills, and learner motivation. The evidence suggests that STEM is highly effective in enhancing students' critical thinking abilities and their eagerness to engage in learning, thus establishing it as a valuable educational approach.

Keywords: *STEM, Critical Thinking Skills, Learner Motivation, Education, Integration, Interdisciplinary, Problem-Solving, Learning Model.*

INTRODUCTION

The rapid progression of society necessitates a concurrent advancement in education to ensure individuals can effectively acclimate to the contemporary landscape using their acquired skills. Education is a developmental process that shapes individuals' mindset, attitudes, character, language proficiency, and their contributions to social life (Safitri et al., 2022). It is a fundamental necessity for human development, as highlighted by various studies (Ismail, Feiby; Jong, C. Y., Sim, A. K., & Lew, T. Y. 2019; Sastrawan & Priyawan, 2020; Abdullah, D, et al, 2023; Uralovich, et al., 2023; Dewi, Patmawati, Asbari, Sasono, & Purwanto, 2023). Internal and external factors significantly influence human development and should be carefully considered to achieve optimal outcomes in the developmental process (Faiz & Kurniawaty, 2022), including advancements in education.

Quality education is characterized by its ability to cultivate critical thinking skills and instill a sense of motivation in students (Zubaidah et al., 2017; Abdelraheem, A.Y. & Ahmed, A.M. 2018; Alt, D., Anjaniputra, A.G. 2020; Raichel, N., & Naamati-Schneider, L, 2022; Alsoud, A.R., et al. 2021; Nobutoshi, 2023; Amin, Adiansyah, & Hujjatusnaini, 2023). Rather than simply memorizing and understanding material, education should empower students to think critically (Hidayati et al., 2019) and foster their interest and motivation to learn (Rahman, 2021). Motivation is a key factor influencing students' success, serving as a driving force for achieving positive outcomes.

Education is closely linked with the curriculum, which must employ diverse learning models to support students' critical thinking and motivation (Ardianto, 2018). One such model is STEM (Science, Technology, Engineering, and Mathematics), particularly in science education. STEM education integrates these disciplines into a cohesive approach, aiming to produce graduates who are not only well-versed in theoretical concepts but

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also adept at applying them in practical contexts. However, the optimal utilization of STEM learning models requires further enhancement by science teachers. This will enable students to enhance their motivation and develop their critical thinking skills during the learning process.

LITERATURE REVIEW

STEM (*Science, Technology, Engineering, and Mathematics*)

STEM (Science, Technology, Engineering, and Mathematics) is an educational approach that integrates these disciplines into learning activities, focusing on solving real-world problems. STEM education demonstrates to learners how concepts, principles, and techniques from these fields can be integrated to develop products, processes, and systems that benefit society. Argumentation is recognized as a crucial component in science learning, as science is built upon the construction of theories supported by explanations and evidence (Yilmaz et al., 2017; Rachmawati, Dwita, and Eli Rohaeti. 2018; Widyanto, I. P., & Vienlentia, R. 2022; Rahim, 2023). Student involvement in scientific argumentation is believed to enhance their conceptual, epistemological, and methodological understanding of science. By applying the STEM learning model, educators aim to improve the quality of learning, expecting that it will help learners integrate Science, Technology, Engineering, and Mathematics, thereby enhancing their argumentation skills. Previous studies have shown that the STEM learning model positively impacts learners' achievement, attitude, interest in learning, and motivation (Davadas, S. D., & Lay, Y. F. 2018; Davidi, E. I. N., Sennen, E., & Supardi, K. 2021; Fatmawati, D. D., & Shofiyah, N. 2022; Pambayun & Shofiyah, 2023).

Critical Thinking Skills

Critical thinking skills encompass higher-order cognitive processes such as analysis, evaluation, and creation (Alsaleh, 2020). These skills enable students to make decisions, engage in strategic planning, navigate scientific processes, and solve problems effectively. The significance of critical thinking skills for learners is universally recognized, evident in their inclusion in educational curricula worldwide (Dökmecioğlu et al., 2020). Critical thinking, as defined by Ennis (1993), is a reasoned, reflective form of thinking that focuses on determining what to believe or do. Encouraging learners to think critically about science and technology is essential for their development of analytical skills and the ability to make informed decisions in daily life (Mapeala & Siew, 2015). The cultivation of critical thinking skills in science education is crucial, providing students with the necessary tools for future life challenges.

Motivation

Motivation is the predominant term used to elucidate the outcomes of nearly any intricate task, whether successful or unsuccessful. Most experts concur that a theory of motivation revolves around the factors that propel behavior and provide it with direction (Rahman, 2021). Motivation to learn can stem from intrinsic factors like the desire to succeed, as well as external factors such as the need for recognition, a supportive environment, and engaging and enjoyable activities. Learning motivation encompasses both internal and external drives in students, influencing changes in their behavior (Nurul Hidayah & Fikki Hermansyah, 2016).

According to Wina Sanjaya (2010: 249), motivation in the learning process is a crucial dynamic aspect. It is often observed that students who underperform are not lacking in ability, but rather lack the motivation to learn, leading them to not fully utilize their abilities. Learning motivation refers to the inner drive in an individual to accomplish a goal. Mc Donald, as cited in Kompri (2016: 229), defines motivation as a change in energy within a person's personality, marked by the emergence of feelings and reactions aimed at achieving goals. This implies that motivation involves a change in energy within an individual, which may or may not result in action. Woodwort (1995), as cited in Wina Sanjaya (2010: 250), states that a motive is a factor that can prompt individuals to engage in specific activities to achieve their goals.

The learning motivation theory utilized in this study is Hamzah B. Uno's theory, which categorizes learning motivation into two groups: intrinsic and extrinsic motivation. According to Uno (2017), intrinsic motivation is characterized by (a) a desire and drive to succeed, (b) encouragement and needs in learning, and (c) future hopes and ideals. On the other hand, extrinsic motivation is characterized by (d) rewards in learning, (e)

interesting desires in learning, and (f) a conducive learning environment.

METHOD

A systematic literature review was undertaken to explore the topic from a theoretical and conceptual perspective, following the guidelines set by the British Educational Research Association (Cohen, Manion, & Morrison, 2011). Initially, a comprehensive search for relevant sources was conducted using Google Scholar and electronic databases spanning various academic fields such as education and psychology. The search utilized diverse terms and their combinations, including STEM learning model, STEM, critical thinking skills, learning motivation, and motivation. These terms formed the foundation of the study's conceptual framework. Subsequently, a conceptual framework was developed to synthesize the key arguments put forth by researchers in this field, as elaborated later. The systematic search predominantly focused on peer-reviewed theoretical and empirical studies pertaining to the teaching of critical thinking skills and students' learning motivation. The search encompassed databases such as Educational Resources Information Center (ERIC), JISTR, and Web of Science, and included articles or reports from reputable research organizations.

FINDINGS AND DISCUSSION

A learning model serves as a blueprint for shaping the curriculum to facilitate effective teaching and learning activities (Khoerunnisa & Aqwal, 2020), contributing to the enhancement of students' hard and soft skills. Various models or approaches, such as cooperative learning, inquiry approaches, discovery learning, project-based learning (PJbL), problem-based learning (PBL), and STEM, can be utilized. Among these, the STEM learning model stands out for its ability to enhance students' critical thinking skills and learning motivation. This model provides students with the stimulation needed to continually improve these skills (Yusuf et al., 2022).

The STEM (Science, Technology, Engineering, and Mathematics) learning model emphasizes multidisciplinary and transdisciplinary integration, fostering the development of critical thinking, creativity, innovation, and problem-solving skills among students. This approach aligns with the characteristics of 21st-century learning and the demands of the Fourth Industrial Revolution. STEM education integrates these subjects into learning activities that are relevant to daily life, enabling students to apply scientific, technological, engineering, and mathematical principles and concepts. This approach encourages students to integrate these principles into learning products or media, as well as apply them in classroom learning (Nurhaliza & Syafitri, 2021).

The goal of the STEM approach in education is to cultivate STEM literacy among students, equipping them with knowledge, positive attitudes, and skills that align with the demands of the 21st century. This prepares students to effectively solve a variety of problems encountered in daily life and to explain natural phenomena (Nurhaliza & Syafitri, 2021). In science education, the STEM model represents a cohesive framework encompassing facts, concepts, principles, procedures, and theories (Usmeldi et al., 2017).

Various research analyses indicate that the STEM learning model can enhance students' abilities, including critical thinking skills, creativity, science literacy, and learning motivation. Research by Aureola Dywan & Septian Airlanda (2020) demonstrated that the blended learning model incorporating the STEM approach was effective in improving students' critical thinking skills. Similarly, the application of STEM in high school science and physics subjects significantly impacts student skills (Nurhaliza & Syafitri, 2021). Utilizing a STEM-oriented Problem-Based Learning (PBL) approach also enhances students' critical thinking skills (Adiwiguna et al., 2019). The PBL-STEM model encourages learning through presented problems, motivating students to investigate, discover, critique, and solve problems. Another aspect studied in the context of critical thinking skills is the ability to analyze problems or argumentation.

In addition to enhancing students' critical thinking skills, the STEM learning model can also boost their learning motivation. This is attributed to students' high curiosity levels in learning. Engaging in meaningful activities using the STEM approach ignites students' enthusiasm for learning, prompting them to strive towards achieving their learning objectives (Hani & Suwarma, 2018). The presence of motivation in learning is crucial for students

to excel in their education (Mayana et al., 2021). With motivation, both intrinsic and extrinsic, students' eagerness to learn can be heightened. Therefore, it is important for teachers to incorporate the STEM approach in teaching, particularly in science subjects.

From the aforementioned explanation, it is evident that the STEM learning model can enhance creative thinking skills, science literacy, critical thinking skills, and student motivation (Aureola Dywan & Septian Airlanda, 2020; Okta et al., 2018; Wahyunita & Subroto, 2021). The STEM approach can be implemented independently or in conjunction with other learning models, depending on the specific learning requirements.

CONCLUSION

The STEM learning model can improve students' critical thinking skills and motivation. This is because the characteristics of the STEM learning model can facilitate learners to explore the knowledge they already have to solve problems in everyday life. Because of the daily life problems that must be solved, learners will have high curiosity so as to stimulate learner motivation.

CONFLICT OF INTEREST

The authors want to highlight that in this study, there were no conflicts of interest. The personal information of participants was protected throughout the research. They were informed that participation was voluntary, and they could choose to withdraw from the study at any point.

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