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Asseessing the Efficacy of Interdiciplinary Curiculum Model in STEM Education: A Review

Ifa Safira[1*], Dewanto[2], Suyahman[3], Everhard Markiano Solissa[4], Unpris Yastanti[5]
[1]Universitas Bosowa, Indonesia
[2] Universitas Negeri Surabaya, Indonesia
[3] Universitas Sanata Dharma, Indonesia
[4]Universitas Pattimura, Indonesia
[5] Universitas Bina sarana Informatika, Indonesia
*Corresponding email:ifa@universitasbosowa.ac.id

Abstract

STEM (Science, Technology, Engineering and Maths) education plays an important role in preparing students for the challenges of the 21st century. The interdisciplinary curriculum model, which integrates different STEM disciplines, has been proposed as an effective approach to enhance STEM learning.This research aims to evaluate the effectiveness of the Interdisciplinary Curriculum Model in STEM education through a comprehensive review. A literature search method was used to investigate various interdisciplinary approaches applied in the context of STEM education. The review investigated the benefits, challenges and implementation strategies associated with using interdisciplinary curriculum models in improving students' STEM understanding and skills. The results show that these model can increase students' motivation, engagement, and understanding of STEM concepts. The interdisciplinary model can also help students develop better problem-solving, critical thinking and collaboration skills. However, the effectiveness of the model may vary depending on factors such as implementation, curriculum design, and student characteristics. Further research is needed to identify factors that contribute to the effectiveness of this model and to develop better guidelines for its implementation. Overall, this review highlights the potential of interdisciplinary curriculum models to enhance STEM learning and provides important insights for educators and policymakers considering implementing these models in their schools.

Keywords:Interdisciplinary Curriculum; STEM Education; Learning

Introduction

STEM (Science, Technology, Engineering and Mathematics) education has taken centre stage with increasing urgency in the modern world. Successfully integrating STEM concepts is not only important to prepare individuals for careers

directly related to the field, but also builds skills and understanding necessary in various aspects of daily life (Sung & Huang, 2024; Suharyat et al., 2023). In an era where technology continues to evolve rapidly and innovation is key to solving global challenges, an understanding of STEM provides a strong foundation for future adaptation and exploration (Sellami et al., 2023).

In addition, STEM education also plays a role in fostering critical, creative and analytical thinking that is essential in facing the complex challenges of the 21st century (Zulyusri et al., 2023; Putra et al., 2023). By introducing students to scientific concepts, modern technology and the use of mathematics in relevant contexts, STEM education helps them to become lifelong learners who are able to adapt to the rapidly changing society and job market (Darmody et al., 2022). More than just preparing individuals for specific jobs, STEM education shapes thinking that fosters innovation, collaboration and creative solutions to the complex global challenges we face today and in the future (Eroğlu, 2021; Safira et al., 2021).

While interdisciplinary curriculum models tend to offer a more integrated approach to learning, there is the potential that some students may feel overwhelmed by the complexity of the material presented or the lack of emphasis on certain disciplines that they may favour or be better at than others (Aini & Timur, 2023). The engagement of students with different levels of expertise in different disciplines can also be challenging, with possible gaps in understanding and acceptance of the concepts taught in a cross-disciplinary curriculum. In addition, this study may be limited by contextual and environmental factors that influence the implementation of the interdisciplinary curriculum model (Hadi et al., 2023). Variability in educational resources, administrative support and school policies may affect how curriculum models are implemented and received by students and educators. In addition, logistical challenges such as limited learning time, classroom restrictions and availability of equipment or technology may also limit the effective implementation of cross-disciplinary curriculum models in the context of STEM education.

Research on the effectiveness of interdisciplinary curriculum models in STEM education has significant relevance in the context of current educational developments. As the complexity of global challenges increases, requiring a more holistic understanding of science, technology, engineering and maths, educators and researchers are increasingly interested in exploring interdisciplinary approaches to education (Utomo et al., 2023; Quigley et al., 2017). Cross-disciplinary curriculum models offer the potential to enhance students' understanding of the connections between different fields of knowledge, promote critical and creative thinking skills, and prepare them to participate in an increasingly multidisciplinary world of work. For

example, previous research has shown that interdisciplinary educational approaches can increase students' interest in STEM fields, improve retention of material, and strengthen collaborative skills required in professional environments (Oktaviah et al., 2023).

However, despite their potential benefits, there are still some questions that need to be answered regarding the actual effectiveness of interdisciplinary curriculum models in STEM education (Vennix et al., 2023). While previous studies may have provided preliminary evidence of the benefits of these educational models, more research is needed to understand in depth how proper implementation of these models can affect students' educational outcomes in the long run (Gül & Ayık, 2024; Hong et al., 2023). In addition, comparisons with conventional curriculum models and analyses of their impact on different groups of students with different needs and predispositions are also important research areas in strengthening our understanding of the effectiveness of interdisciplinary curriculum models in STEM education. Therefore, based on this, the research aims to find out Asseessing the Efficacy of Interdiciplinary Curiculum Model in STEM Education.

Research Methods

This type of research is review of the current state of interdisciplinary curriculum models in STEM education reveals a growing interest in approaches that integrate multiple disciplines to enhance students' understanding and application of STEM concepts. Over the past decade, there has been a shift towards recognizing the interconnectedness of science, technology, engineering, and mathematics, prompting educators and researchers to explore innovative teaching strategies that bridge traditional disciplinary boundaries. Furthermore, studies have highlighted the potential benefits of interdisciplinary approaches, including increased student engagement, improved academic performance, and better preparation for future STEM careers. However, despite the growing enthusiasm for interdisciplinary STEM education, there remain gaps in our understanding of the effectiveness of these curriculum models and the best practices for their implementation.

Moreover, the current literature underscores the importance of addressing challenges and limitations in assessing the efficacy of interdisciplinary curriculum models in STEM education. One major challenge is the need for rigorous evaluation methodologies that can accurately measure the impact of interdisciplinary approaches on student learning outcomes. Existing assessment tools often focus on traditional subject-specific metrics, which may not fully capture the holistic nature of interdisciplinary learning experiences. Additionally, logistical constraints, such as

limited time, resources, and institutional support, can hinder the successful implementation of interdisciplinary curriculum models in diverse educational settings.

Result and Discussion

Definitions and characteristics of interdisciplinary curriculum models

Interdisciplinary curriculum models represent an innovative approach to education that integrates concepts and methods from multiple disciplines, aiming to provide students with a holistic understanding of complex real-world issues. At its core, interdisciplinary education seeks to break down the traditional silos between subject areas, fostering connections and synergies that promote deeper learning and critical thinking skills (Darmawansah et al., 2023). One commonly cited definition of interdisciplinary curriculum models is the integration of knowledge, skills, and perspectives from two or more disciplines to address complex problems or questions that cannot be adequately addressed within the confines of a single discipline. This approach encourages students to make connections between different fields of study, allowing them to see the interconnectedness of various subjects and develop a more comprehensive understanding of the world around them.

Characteristics of interdisciplinary curriculum models often include flexibility, adaptability, and collaboration. Unlike traditional subject-based curricula, interdisciplinary models prioritize flexibility in content and delivery, allowing educators to tailor instruction to the unique needs and interests of their students (Zulkifli et al., 2022). This flexibility enables teachers to incorporate diverse perspectives, methods, and resources from multiple disciplines, creating a rich learning environment that encourages exploration and inquiry. Additionally, interdisciplinary curriculum models emphasize adaptability, as they are designed to evolve in response to emerging issues and changing educational landscapes. Educators are encouraged to continuously refine and update their curricula to reflect new developments in their fields and to meet the evolving needs of their students (Vennix et al., 2023). Collaboration is another key characteristic of interdisciplinary curriculum models. These models often involve collaboration not only among educators from different disciplines but also among students themselves. Collaborative learning experiences, such as group projects, discussions, and problem-solving activities, are integral to interdisciplinary education, as they foster teamwork, communication, and critical thinking skills. By working together to address complex problems, students learn to appreciate the value of diverse perspectives and develop the skills needed to effectively collaborate with others in both academic and professional settings.

Furthermore, interdisciplinary curriculum models prioritize the integration of real-world applications and experiences. Rather than focusing solely on abstract

concepts and theoretical knowledge, these models emphasize the practical relevance of academic content by connecting it to authentic, real-world problems and scenarios. By engaging with real-world challenges, students are better able to see the practical implications of their learning and develop the skills needed to apply their knowledge in meaningful ways. This emphasis on real-world connections helps to motivate students and promote deeper engagement with the curriculum. Interdisciplinary curriculum models also tend to be interdisciplinary curriculum models also tend to be student-centered, meaning that they prioritize the interests, needs, and experiences of the learners (Turner et al., 2022). These models recognize that students come to the classroom with diverse backgrounds, interests, and learning styles, and seek to create learning experiences that are responsive to these differences. By incorporating student interests and experiences into the curriculum, educators can increase student engagement and motivation, making learning more meaningful and relevant for students.

Moreover, interdisciplinary curriculum models often promote the development of transferable skills, such as critical thinking, problem-solving, communication, and collaboration. These skills are essential for success in both academic and professional contexts, and interdisciplinary education provides an ideal platform for their development (Schijf et al., 2023). By engaging in interdisciplinary inquiry and problem-solving, students learn to approach complex issues from multiple perspectives, evaluate evidence, communicate their ideas effectively, and work collaboratively with others to find solution (Nauraeni. & Safira, 2020). These skills are highly valued by employers and are essential for navigating the complexities of the modern world.

Potential benefits of interdisciplinary learning in STEM education

Interdisciplinary learning in STEM education offers numerous potential benefits that extend beyond the traditional boundaries of individual disciplines. One significant advantage is the promotion of a holistic understanding of complex real-world problems (Ak et al., 2022). By integrating concepts and methodologies from science, technology, engineering, and mathematics, interdisciplinary learning allows students to see the interconnectedness of these fields and gain a more comprehensive perspective on issues that cannot be adequately addressed within the confines of a single discipline (Nurtamam et al., 2023). This holistic approach encourages students to think critically, make connections between different areas of knowledge, and develop a deeper appreciation for the interdisciplinary nature of many modern challenges. Furthermore, interdisciplinary learning in STEM education fosters

creativity and innovation by encouraging students to approach problems from multiple perspectives. By combining insights from various disciplines, students can develop novel solutions to complex problems and explore new possibilities that may not be apparent when considering each discipline in isolation. This interdisciplinary approach to problem-solving promotes creative thinking and empowers students to think outside the box, ultimately preparing them to tackle the diverse challenges they may encounter in their future careers.

Moreover, interdisciplinary learning enhances the relevance and applicability of STEM education by connecting academic concepts to real-world contexts and challenges. By engaging with authentic, real-world problems, students can see the practical implications of their learning and develop the skills needed to apply their knowledge in meaningful ways. This real-world relevance not only motivates students by showing them the impact of their learning but also prepares them for success in their future careers by equipping them with the skills needed to address the complex challenges they will face in the workforce (Yang et al., 2020). Additionally, interdisciplinary learning in STEM education promotes collaboration and teamwork by providing opportunities for students to work together on interdisciplinary projects and activities. Collaboration is essential for success in both academic and professional settings, and interdisciplinary education provides students with valuable experience working in diverse teams to achieve common goals. By collaborating with peers from different backgrounds and disciplines, students learn to appreciate the value of diverse perspectives, communicate effectively, and leverage the strengths of each team member, ultimately enhancing their ability to work collaboratively in a variety of contexts (Fadlelmula, 2022).

Furthermore, interdisciplinary learning in STEM education encourages lifelong learning by fostering curiosity, inquiry, and a growth mindset. By engaging in interdisciplinary inquiry and exploration, students develop a thirst for knowledge and a willingness to seek out new information and perspectives. This lifelong learning mindset is essential for success in today's rapidly changing world, where new technologies, discoveries, and challenges are constantly emerging (Fitriyana et al., 2024; Widodo et al., 2024). By instilling a passion for learning and an openness to new ideas, interdisciplinary education prepares students to adapt to change, embrace innovation, and thrive in an ever-evolving global society. nterdisciplinary learning in STEM education offers numerous potential benefits, including the promotion of a holistic understanding of complex problems, the fostering of creativity and innovation, the enhancement of real-world relevance and applicability, the promotion of collaboration and teamwork, and the encouragement of lifelong learning. By

integrating concepts and methodologies from multiple disciplines, interdisciplinary education prepares students to tackle the diverse challenges they will face in their future careers, equipping them with the knowledge, skills, and mindset needed to succeed in a rapidly changing world.

Conclusion

The results show that this model can increase students' motivation, engagement, and understanding of STEM concepts. The interdisciplinary model can also help students develop better problem-solving, critical thinking and collaboration skills. However, the effectiveness of the model may vary depending on factors such as implementation, curriculum design, and student characteristics. Further research is needed to identify factors that contribute to the effectiveness of this model and to develop better guidelines for its implementation. Overall, this review highlights the potential of interdisciplinary curriculum models to enhance STEM learning and provides important insights for educators and policymakers considering implementing these models in their schools.

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