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Teaching And Learning Of Mathematics For Stem Education: Issues, Challenges And Probable Solutions

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ABSTRACT
STEM education integrating Science, Technology, Engineering and Mathematics emphasizes the critical role of mathematics as a foundational tool for problem solving and innovation. The paper highlight the significance of mathematics in STEM curricula. Mathematics education is vital for preparing future of graduates in STEM fields. The paper discusses mathematics, teaching and learning of mathematics, STEM Education, issues and challenges with probable solution. Conclusion and recommendations were made. One of the recommendation is to encourage collaboration between mathematics and other STEM discipline to deepen understanding and application of concepts. Therefore mathematics is a necessary tool for STEM Education.
Keywords: mathematics, STEM Education, learning, problem solving

INTRODUCTION

Mathematics educators have put up noble and spirited efforts aimed at identifying the major problems associated with the teaching and learning of mathematics in the nation's schools. Despite all these noble efforts, the problem of poor achievement in mathematics has continued to rear its head in the nation. The general state of affairs of education in the country is despite several efforts of the government to encourage teachers to improve the academic achievement of students as well as get students interested in studying mathematics. The problem is to ensure effective teaching and learning, of mathematics to have sound and solid foundation for science, technology and engineering through mathematics (STEM).

Mathematics is a prime instrument for understanding and exploring scientific, economic and social world. In addition to this usefulness, Mathematics serve as a tool for creating new knowledge in all fields for solving problems, stating theories and predicting outcomes. Mathematics is a science; observations, experiment, discovery, and conjecture are as much part of the practice of mathematics as of any natural science. Trial and error, hypothesis and investigation, and measurement and classification are part of the mathematician's craft and should be taught in school. Mathematics as a subject that has been made a core such that all students regardless of discipline, gender or ability most pass it at credit level especially in secondary schools; National policy on Education(FRN, 2013). Teachers are person who help others to acquire knowledge, competence and values. The world today is witnessing a rapid growth in the development of science and technology with the advent of computer and other information and communication technology. It is believed that hardly can a country survive the pressure of the recent information and communication technology popularly known as IT without mathematics (Azuka, 2014).

Mathematics teaching is defined as the intellectual ability of educators to apply appropriate methods for imparting mathematical knowledge, fostering logical reasoning and concentration among

students1. It involves creating opportunities for learning through supportive environments and challenges. Mathematics learning, on the other hand, is the acquisition of knowledge and skills related to quantities, space, and structure, resulting in a relatively permanent change in behavior due to experiences. Both processes are interdependent, emphasizing the importance of effective teaching strategies in facilitating meaningful learning experiences

Mathematics learning is defined as the acquisition of knowledge and skills related to mathematical concepts, which can be facilitated through various teaching methods (Verschaffel et al., 2012). Constructivist approaches emphasize the importance of prior knowledge and active participation in the learning process (Major & Mangope, 2012).

Teaching and learning mathematics encompass a complex interplay of pedagogical strategies, student engagement, and cognitive development. Effective mathematics teaching involves creating a supportive learning environment that fosters mathematical reasoning and problem-solving skills. Strategies such as explicit instruction, cooperative learning, and hands-on activities are essential for engaging students and enhancing their understanding (Jaworski, 2006; Aduwa, 2021).

Science involves the systematic study of the structure and behavior of the natural and physical world. In STEM education, it promotes inquiry-based learning, where students develop hypotheses, experiment, and analyze data. Technology encompasses the tools, machines, and processes that help solve problems or perform tasks. Technology in STEM education includes understanding how devices work and how they can be applied or adapted to solve issues. Engineering focuses on designing, building, and testing solutions to real-world problems. Engineering principles in STEM help students approach challenges systematically. Mathematics is the foundational language of STEM, involving numbers, calculations, and analytical thinking. Mathematics provides the logical structure to analyze and quantify scientific and engineering concepts. STEM education integrates these areas into a cohesive learning paradigm, where lessons encourage students to think across disciplines rather than in isolated subjects.

Importance of STEM Education

Filling the Skills Gap: As the global economy shifts towards technology and innovation, the demand for STEM skills is increasing. Many industries, including healthcare, information technology, manufacturing, and energy, are seeking employees who are adept in these areas.

Economic Development: STEM drives economic growth by fostering a skilled workforce. Countries with strong STEM education systems can develop cutting-edge technologies, boost productivity, and remain competitive.

Problem-Solving and Critical Thinking: STEM learning fosters analytical thinking, resilience, and adaptability. Students in STEM are often presented with complex, open-ended problems that require creative solutions.

Global Challenges: STEM is essential for addressing major global challenges, such as climate change, renewable energy, food security, and public health. By preparing students in these fields, STEM education can help tackle issues affecting communities worldwide.

STEM education, an acronym for Science, Technology, Engineering, and Mathematics, is an interdisciplinary approach that integrates these fields into cohesive learning experiences. This educational framework emphasizes real-world applications and problem-solving, encouraging students to engage in hands-on activities that foster critical thinking and creativity (Bhatnagar, 2021; TechTarget, 2022).

The goal of STEM education is to prepare students for future careers in a rapidly evolving job market by equipping them with essential skills such as collaboration, digital literacy, and analytical thinking (Department of Education, 2024). This approach not only enhances academic performance but also promotes innovation and adaptability in various professional fields (Live Science, 2022). Mathematics teaching and learning for STEM education involves several critical aspects that enhance student engagement and understanding which includes:-

Integration of Disciplines: Effective STEM education requires a seamless integration of mathematics with science, technology, and engineering. This integration should highlight the relevance of mathematics in solving real-world problems (English, 2016; Tytler et al., 2023).

Cognitive Demand: Tasks should promote higher-order thinking by requiring students to engage in problem-solving, reasoning, and mathematical modeling. However, many current tasks often demand low cognitive engagement, which needs to be addressed (Tytler et al., 2023) .

Real-World Applications: Mathematics should be taught through authentic contexts that connect to students' lives and future careers. This relevance can increase interest and motivation (Fitzmaurice et al., 2021).

Collaborative Learning: Encouraging teamwork in problem-solving tasks allows students to learn from peers and fosters a deeper understanding of mathematical concepts (Roehrig et al., 2021).

Focus on Sense-Making: Mathematics should be viewed as a sense-making activity rather than just a set of procedures to memorize. This perspective encourages students to understand the underlying concepts (Stohlmann, 2018). Mathematics teaching and learning through STEM faces several issues and challenges, along with potential solutions:

Issues and Challenges

Integration of Disciplines: Mathematics is often overshadowed by science in STEM education, leading to a lack of emphasis on its importance (English, 2015) .

Teacher Preparedness: Many teachers lack training in effectively integrating mathematics within STEM frameworks, hindering the development of appropriate curricula (Yunus, 2018) .

Student Engagement: There are challenges in creating engaging tasks that maintain the integrity of mathematical concepts while being relevant to real-world applications (Tytler et al., 2023)

Lack of Resources and Funding: Many schools struggle to provide adequate materials and technology necessary for effective STEM instruction. Insufficient funding limits access to up-to-date tools and engaging learning environments (21stCentEd, 2022; Qureshi & Qureshi, 2021).

Curriculum Integration: Integrating STEM subjects into existing curricula can be complex. Teachers often find it challenging to create interdisciplinary lessons that align with standardized testing requirements while making learning relevant (21stCentEd, 2022).

Teacher Preparation and Professional Development: Many educators lack the training necessary to teach STEM subjects effectively. This gap in knowledge can hinder their ability to implement innovative teaching methods (SciTePress, 2018; Qureshi & Qureshi, 2021).

Addressing Misconceptions and Stereotypes: Persistent stereotypes about who can excel in STEM fields—particularly regarding gender—can discourage students from pursuing these subjects (21stCentEd, 2022; SciTePress, 2018).

Engaging Students: Keeping students interested in STEM can be difficult, especially if they perceive the subjects as boring or irrelevant to their lives (Qureshi & Qureshi, 2021).

Diverse Student Needs: Students come with varying backgrounds and learning styles, making it challenging to design lessons that cater to everyone (21stCentEd, 2022).

Probable Solutions

Professional Development: Providing ongoing professional learning for teachers to enhance their skills in integrated STEM teaching can improve mathematics engagement (Anderson et al., 2023) 1. Collaborative Curriculum Design: Encouraging collaboration among STEM educators to design interdisciplinary projects can foster better integration of mathematics (Roehrig et al., 2021) 2. Focus on Real-World Applications: Emphasizing real-world problem-solving in mathematics can increase student interest and understanding (Volmert et al., 2013)

3. Secure Funding and Resources: Schools can seek grants and community partnerships to enhance their STEM programs. Resource-sharing initiatives between schools can also help mitigate funding disparities (21stCentEd, 2022; SciTePress, 2018).

4. Professional Development Programs: Investing in ongoing training for teachers focused on STEM education can help them feel more prepared and confident in delivering these subjects (Qureshi & Qureshi, 2021; SciTePress, 2018).

5. Interdisciplinary Projects: Designing projects that incorporate multiple STEM disciplines can help integrate these subjects more effectively into the curriculum while making learning relevant (21stCentEd, 2022).

6. Promote Inclusivity: Highlighting diverse role models in STEM fields and creating an inclusive curriculum can help break down stereotypes and encourage all students to engage with STEM subjects (21stCentEd, 2022).
7. Engaging Teaching Methods: Utilizing hands-on activities and real-world applications can make STEM subjects more engaging for students (Qureshi & Qureshi, 2021).
8. Differentiated Instruction: Employing various teaching strategies tailored to different learning styles can help meet the diverse needs of students in a STEM classroom (21stCentEd, 2022; SciTePress, 2018).

By addressing these challenges through targeted solutions, educators can enhance the effectiveness of STEM education and better prepare students for future careers in these critical fields.

CONCLUSION

STEM education, particularly through mathematics, significantly enhances student learning outcomes. Research indicates that integrating STEM approaches into mathematics instruction fosters critical thinking, collaboration, and creativity among students, leading to improved mathematical achievement. Meta-analyses show substantial effect sizes for STEM education on learning outcomes, particularly when combined with mastery learning strategies. Additionally, teachers recognize the vital role of mathematics in interdisciplinary STEM contexts, which promotes deeper understanding and application of mathematical concepts45. Overall, effective STEM integration in mathematics education is essential for preparing students for future challenges in STEM careers.

RECOMMENDATIONS

To enhance STEM education through mathematics teaching and learning. Here are some recommendations:

1. Integrate Real-World Problems: Use challenging, engaging problems that connect mathematics to real-life STEM applications, fostering critical thinking and problem-solving skills
2. Promote Interdisciplinary Learning: Encourage collaboration between mathematics and other STEM disciplines to deepen understanding and application of concepts
3. Utilize Technology: Leverage technology for personalized learning experiences, enabling adaptive learning and immediate feedback
4. Professional Development: Provide ongoing training for educators to implement effective STEM practices and integrate them into mathematics instruction
5. Supportive Curriculum Design: Develop curricula that emphasize mathematical reasoning within STEM contexts, ensuring alignment with educational standards

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