

Advocating Students' Resilience in STEM Subjects in Tertiary Institutions

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ABSTRACT

Resilience in Science, Technology, Engineering, and Mathematics (STEM) education has become an essential attribute for students in tertiary institutions. Resilience is essential for students in Science, Technology, Engineering, and Mathematics (STEM) education due to the challenging nature of these fields. It enables students to persist through difficult coursework, handle academic pressure, and overcome failures, ultimately leading to academic success. Promoting resilience helps students manage stress, maintain mental health, and engage with complex STEM concepts. With the increasing complexity and challenges of STEM subjects, students often face academic, emotional, and psychological difficulties that can hinder their success. This paper advocates for promoting resilience among students in STEM disciplines by exploring strategies to enhance their ability to adapt, overcome challenges, and maintain motivation. The discussion focuses on the importance of resilience, challenges in STEM education, and strategies for fostering a resilient mindset among students. Key recommendations for fostering resilience in STEM students include promoting a growth mindset, incorporating mentorship programs, and encouraging collaborative learning. Growth mindset initiatives help students view challenges as learning opportunities, while mentorship provides guidance and emotional support. Collaborative learning reduces isolation and promotes teamwork, which boosts resilience. Additionally, institutions should provide mental health resources, support underrepresented groups in STEM, and integrate real-world applications into the curriculum. Flexible assessment methods that allow students to learn from mistakes are also important, as they encourage a positive attitude toward failure. By creating a culture of resilience through policies and leadership, tertiary institutions can equip students with the skills they need to succeed academically and in their future STEM careers.

Keywords:

Students' Resilience, STEM Subjects, Tertiary Institutions

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INTRODUCTION

Science, Technology, Engineering, and Mathematics (STEM) education is widely regarded as a cornerstone of innovation and economic development in today's society. Tertiary institutions play a critical role in training the next generation of STEM professionals, yet many students face considerable challenges in these demanding fields. High levels of academic rigor, complex concepts, and the competitive nature of STEM disciplines can overwhelm students, resulting in disengagement and high dropout rates (Trenor et al., 2020). To combat these challenges, fostering resilience—defined as the ability to adapt and thrive despite difficulties—is essential for success in STEM education. STEM subjects are fundamental to the development of critical skills required in today's technological and innovation-driven world. However, these subjects are often seen as difficult and demanding, leading to high attrition rates and low student motivation. In tertiary institutions, where students are expected to master complex concepts and engage in rigorous problem-solving, the ability to persevere through academic adversity is crucial. Resilience—defined as the capacity to recover quickly from difficulties and maintain positive

mental health despite challenges—is therefore a critical trait for students to succeed in STEM fields (Masten, 2018).

Resilience in students is not just about bouncing back from failure; it is also about maintaining a positive attitude, developing coping mechanisms, and continuing to engage with challenging material (Masten, 2018). In Science, Technology, Engineering, and Mathematics (STEM) education, where setbacks are a common part of the learning process, resilience plays a critical role in sustaining students' motivation and commitment to their academic goals. Resilient students are better equipped to adapt to complex academic challenges, persist through difficulties, and develop problem-solving skills that are essential for success in STEM fields. This aligns with the view that effective learning environments should foster perseverance, self-regulation, and adaptability to ensure employability and global competitiveness (Osegbue, Manafa & Ohamobi, 2018). Furthermore, resilience is closely tied to institutional strategies that promote effective school management and quality assurance. A supportive and well-coordinated learning structure helps students build confidence and emotional strength to face academic demands (Ohamobi & Manafa, 2022; Okafor, Ohamobi & Manafa, 2021). Political and administrative factors can also shape the environment that either strengthens or weakens students' coping abilities (Ohamobi, Osegbue & Manafa, 2021). Recent theoretical perspectives emphasize integrating artificial and emotional intelligence in school leadership to create adaptive systems that support student resilience (Ohamobi & Osegbue, 2025).

One of the major challenges faced by students in STEM subjects is the nature of the curriculum itself, which often involves abstract concepts, complex problem-solving, and intensive workloads (Wang & Degol, 2017). The perceived difficulty of these subjects can lead to frustration and anxiety, with many students feeling that they are not “cut out” for STEM. This phenomenon is particularly evident in the first few years of tertiary education when the transition from secondary school to university-level STEM courses can be overwhelming. According to Seymour and Hewitt (2019), a significant number of students leave STEM disciplines within their first two years, citing academic difficulty and lack of support as primary reasons. Another critical factor affecting student resilience is the lack of representation and support for women and minority groups in STEM fields. Research shows that these underrepresented groups often face additional barriers such as bias, isolation, and a lack of role models, making it even more difficult for them to persist in STEM programs (Maltese & Tai, 2016). Addressing these issues is vital not only for fostering diversity in STEM fields but also for ensuring that all students, regardless of background, can develop the resilience needed to succeed.

Promoting resilience in STEM students requires a multifaceted approach that includes fostering a growth mindset, providing mentorship, creating supportive learning environments, and addressing the unique needs of underrepresented groups. Dweck's (2006) concept of a growth mindset—believing that abilities can be developed through effort and learning from failure—is particularly relevant in STEM education. Students who adopt a growth mindset are more likely to persevere through challenges and view failures as opportunities for improvement, rather than as indicators of their abilities. According to Dweck (2006), students with a growth mindset are more likely to persist in STEM fields, as they believe that their intelligence and skills can be developed through effort and learning.

Mentorship and peer support are also crucial in helping students build resilience. According to Trenor et al. (2020), students with access to mentors and supportive peer networks are more likely to persist in STEM disciplines, as they feel less isolated and more equipped to handle challenges. Mentorship has been shown to reduce feelings of isolation, provide encouragement, and offer practical advice on overcoming academic challenges (Trenor et al., 2020). Mentors provide guidance, share experiences, and offer emotional support, which can help students stay motivated and focused on their long-term goals.

Furthermore, tertiary institutions must create learning environments that encourage collaboration, rather than competition, and provide opportunities for students to engage with real-world problems. Collaborative learning not only helps students develop teamwork and communication skills but also reduces feelings of isolation and frustration that can arise in competitive STEM programs (Johnson & Johnson, 2019). Collaborative projects help reduce the competitive atmosphere often associated with STEM, and can alleviate individual stress by allowing students to work together towards common goals (Johnson & Johnson, 2019). Real-world applications of STEM concepts can also enhance students' motivation by showing them the relevance and impact of their studies.

METHODOLOGY

This study adopted a scoping review research design to map and synthesize existing literature on strategies for fostering students' resilience in Science, Technology, Engineering, and Mathematics (STEM) subjects in tertiary institutions. The scoping review approach was chosen to provide a comprehensive overview of current evidence, identify research gaps, and highlight effective practices that support resilience development. Relevant peer-reviewed articles, books, and institutional reports published between 2006 and 2025 were systematically searched using databases such as Google Scholar, ERIC, and ResearchGate. Keywords including resilience, STEM education, tertiary institutions, growth mindset, and mentorship guided the search process. Inclusion criteria focused on studies addressing student motivation, coping mechanisms, academic challenges, and institutional interventions in STEM education. Selected literature was analyzed through thematic content analysis to identify recurring themes such as growth mindset promotion, mentorship, collaborative learning, and mental health support.

RESULTS

The Importance of Resilience in STEM Education

Resilience enables students to navigate the difficulties associated with STEM disciplines, which often require strong problem-solving skills, persistence, and adaptability. STEM courses frequently present students with new, abstract, and often challenging material. According to Wang and Degol (2017), resilience is associated with a higher likelihood of students overcoming challenges and persisting in their studies, despite setbacks. Moreover, resilience plays a crucial role in reducing stress and anxiety, both of which are common among STEM students due to the high academic demands and competitive environment. Furthermore, resilience is not just important for academic performance but also for students' mental well-being. STEM students are often under pressure to meet high expectations, which can lead to burnout, anxiety, and depression (Trenor et al., 2020). Resilience can act as a buffer, helping students cope with these pressures and maintain their motivation to achieve their academic and career goals.

Resilience plays a crucial role in the educational journey of students pursuing Science, Technology, Engineering, and Mathematics (STEM) subjects. Given the rigor and complexity of STEM disciplines, students often face numerous challenges, including difficult coursework, high academic expectations, and the need to apply abstract concepts in real-world problem-solving scenarios. The ability to persist in the face of these challenges—demonstrated through resilience—is key to academic success in STEM fields. Without resilience, students may become discouraged by failure, lose motivation, and eventually leave the field (Trenor et al., 2020). This makes resilience an indispensable quality for both individual success and the cultivation of a skilled STEM workforce capable of addressing modern global challenges.

Resilience and Academic Performance

Resilience directly impacts a student's academic performance in STEM subjects. These disciplines demand a high level of persistence and problem-solving ability, which can only be

cultivated through repeated engagement with difficult tasks. According to Masten (2018), resilience is defined as the capacity to recover from setbacks, adapt well to change, and keep going in the face of adversity. In the context of STEM, where students often encounter failure as part of the learning process, resilience allows them to maintain focus, recalibrate their strategies, and continue learning from their mistakes. This positive, adaptive behavior is essential for mastering complex topics such as advanced mathematics, physics, or engineering.

Students with resilience tend to perceive challenges as opportunities for personal and academic growth rather than insurmountable barriers. This adaptive mindset enables them to remain engaged and motivated in Science, Technology, Engineering, and Mathematics (STEM) subjects, even when confronted with complex material. Dweck's (2006) theory of growth mindset reinforces this view, emphasizing that students who believe their abilities can improve through effort and perseverance are more likely to persist and succeed in challenging contexts. In STEM education, resilience transforms setbacks into valuable learning experiences by encouraging students to seek help, reassess strategies, and deepen their understanding of difficult concepts. Leadership and support systems within educational institutions play a key role in nurturing such resilience. Effective leadership practices enhance supervision, provide mentorship, and create environments that foster persistence and self-belief among learners (Osegbue, Manafa & Ohamobi, 2018). Similarly, access to guidance and counselling services strengthens students' emotional stability and academic engagement, helping them manage academic pressures constructively (Ohamobi, Akulue & Okonkwo, 2021). The integration of educational support services and effective administrative strategies has also been linked to improved quality assurance and student outcomes (Ezugoh, Onuorah & Ohamobi, 2024; Ohamobi & Anasiudu, 2021). Thus, resilience, reinforced by supportive institutional leadership, remains central to sustained success in STEM education.

Resilience and Mental Health

STEM students often face stress and anxiety due to the demanding nature of their coursework. Long hours of study, high-stakes assessments, and the competitive environment can take a toll on students' mental well-being. Resilience plays a protective role by enabling students to manage academic stress and maintain their mental health (Salmela-Aro & Read, 2017). It helps students cope with pressure and prevents burnout by fostering emotional regulation, problem-solving skills, and a positive outlook despite difficulties. The ability to bounce back from challenges is particularly important in STEM, where the learning process often involves trial and error. Students who lack resilience may struggle with feelings of failure or inadequacy, which can negatively impact their academic performance and lead to mental health issues such as anxiety and depression (Maltese & Tai, 2016). Resilience helps students maintain a balanced perspective, manage setbacks, and continue progressing toward their goals without becoming overwhelmed.

Resilience and Diversity in STEM

Resilience is also critical for underrepresented groups in STEM, such as women and minority students, who often face additional challenges. These groups may encounter bias, discrimination, or isolation in STEM fields, which can make it more difficult for them to persist in their studies (Wang & Degol, 2017). Resilience helps these students navigate such challenges by fostering a sense of self-efficacy, encouraging persistence, and helping them to remain focused on their academic goals despite external pressures.

Research indicates that women and minority students who demonstrate resilience are more likely to succeed in STEM disciplines, despite the structural barriers they may face (Maltese & Tai, 2016). By fostering resilience in these groups, educators and institutions can help reduce attrition rates and support a more diverse and inclusive STEM workforce.

Resilience and Future Careers in STEM

The importance of resilience extends beyond academic performance and into future STEM careers. The ability to cope with uncertainty, adapt to changing environments, and persist in solving complex problems is highly valued in STEM-related professions. Engineers, scientists, and technologists frequently encounter unforeseen challenges in their work, and resilience allows them to continue innovating and finding solutions even when immediate success is not guaranteed (Trenor et al., 2020). By cultivating resilience in students, tertiary institutions help prepare them not only for academic success but also for long-term career success in STEM fields.

Challenges in STEM Education

Several challenges make STEM education particularly difficult for students. First, the curriculum in STEM disciplines is often dense and fast-paced, requiring students to learn complex theories and apply them in practical settings. Many students struggle with the abstract nature of subjects like physics, calculus, and engineering, which can lead to frustration and a sense of failure.

Second, the competitive nature of STEM programs can discourage students who are not immediately successful. In a study by Seymour and Hewitt (2019), many students who left STEM fields reported feelings of inadequacy and a lack of support as reasons for their departure. The difficulty of the coursework, combined with the perception that success is limited to a few, creates an environment where students can feel isolated and overwhelmed.

Another challenge is the underrepresentation of certain demographic groups in STEM, particularly women and minorities. According to Maltese and Tai (2016), these groups often face additional obstacles such as bias, lack of role models, and limited access to resources, making resilience even more critical for their success in STEM fields.

Fostering Resilience in STEM Students

To promote resilience in STEM education, it is essential to create a supportive learning environment that encourages perseverance and adaptability. Below are strategies for fostering resilience among STEM students:

1. **The establishment of a growth mindset**

The development of resilience needs to encourage students to adopt a growth mindset, in which they regard setbacks not as obstacles to their achievement but rather as chances for the expansion of their knowledge. Research conducted by Carol Dweck (2006) on mindset reveals that students who have the belief that their capabilities may be improved via the application of effort are more likely to persevere in challenging courses such as STEM classes. Educators can foster a growth mindset by advocating for the importance of effort above innate talent and by providing students with positive feedback that encourages them to continue their efforts.

2. **Support and Mentoring Networks for Individuals**

It is possible to assist students in navigating the hurdles that STEM education presents by providing them with mentorship and support networks. Mentoring includes providing assistance, support, and advice on how to overcome academic and personal problems. Mentors might be members of the faculty, graduate students, or professionals working in the field. According to the findings of Trenor et al. (2020), students who have excellent mentorship relationships have a greater chance of developing resilience and succeeding in their academic endeavours.

3. **Creating Learning Environments That Encourage Collaborative Work**

Learning environments that encourage collaboration among students allow students to work together to find solutions to issues, which in turn reduces feelings of isolation and frustration. According to Johnson and Johnson (2019), students can benefit from having a

support system in the form of group work, peer tutoring, and study groups. This support system allows students to share their ideas, learn from each other, and develop confidence in their own talents. The development of abilities in cooperation, which are necessary for success in both academic and professional STEM contexts, can also be advanced through the use of these environments.

4. The incorporation of applications from the real world

When it comes to studies in the STEM fields, students frequently struggle because they are unable to perceive the relevance of what they are studying. It is possible to assist students in comprehending the practical significance of STEM topics and to keep their drive to persevere by incorporating real-world applications into the curriculum. For example, Chen and Chang (2019) shown that project-based learning, which involves tying STEM ideas to the solution of real-life problems, has the potential to make learning more relevant and engaging.

5. Offering both academic and emotional support to the student

In addition to providing access to academic support services, tertiary institutions should also make available emotional support services, such as counselling, workshops on stress management, and tutoring. These resources can assist students in developing coping techniques that will assist them in managing the academic pressure that is inherent in STEM and related professions. Counselling services, in particular, have the potential to assist students in developing emotional resilience and coping with stress, anxiety, or feelings of inadequacy (Salmela-Aro & Read, 2017).

CONCLUSION

Building resilience among STEM students is essential for their academic success and overall well-being. Resilience helps students to overcome the difficulties associated with STEM subjects, remain motivated, and persevere through challenges. Tertiary institutions should take proactive steps to foster resilience by promoting a growth mindset, providing mentorship and support, creating collaborative learning environments, integrating real-world applications into the curriculum, and offering emotional and academic support services. By advocating for resilience, educators and institutions can help students navigate the complexities of STEM education and prepare them for success in their future careers. Advocating for resilience in STEM subjects is essential for ensuring that students in tertiary institutions can overcome the challenges they face and succeed in these critical fields. By promoting a growth mindset, providing mentorship, and creating supportive, collaborative learning environments, educators and institutions can help students develop the resilience needed to thrive in STEM. This, in turn, will contribute to the cultivation of a robust, innovative workforce capable of addressing the complex challenges of the modern world. Resilience is a critical factor in the success of STEM students, enabling them to persist through academic challenges, maintain mental health, and overcome barriers faced by underrepresented groups. By fostering resilience through supportive learning environments, mentorship, and growth mindset strategies, educators can help students develop the perseverance needed to thrive in STEM subjects. This, in turn, strengthens the future STEM workforce, equipping it to tackle the complex global issues of the 21st century.

RECOMMENDATIONS

To enhance students' resilience in Science, Technology, Engineering, and Mathematics (STEM) subjects within tertiary institutions, several targeted recommendations can be made. These recommendations aim to improve students' capacity to handle academic challenges, foster a growth mindset, and ensure that they are better equipped to thrive in demanding STEM disciplines.

1. Educators should actively foster a growth mindset, where students are encouraged to view challenges and failures as opportunities for learning rather than as indicators of fixed abilities. Schools and universities can implement growth mindset training programs to help students understand the importance of perseverance and continuous improvement in STEM.
2. Mentorship programs should be established within tertiary institutions to provide students with guidance, emotional support, and role models in STEM disciplines. These programs should include both faculty mentors and peer mentors to create a more inclusive support system for students.
3. Institutions should encourage more collaborative learning environments in STEM education. By promoting teamwork, students can develop resilience through shared problem-solving experiences and peer support. This approach promotes both academic and emotional resilience by fostering a sense of community among STEM students.
4. Tertiary institutions must provide adequate mental health resources for STEM students to help them cope with stress, anxiety, and burnout, which are common challenges in STEM education. Additionally, mental health resources should be made easily accessible, and students should be encouraged to seek help when needed.
5. Special attention should be given to supporting women, minority students, and other underrepresented groups in STEM disciplines. Institutions should create diversity programs, scholarships, and targeted support networks to help these students navigate the challenges unique to their experiences. Providing visible role models and mentors from underrepresented groups is essential for fostering a sense of belonging and perseverance in these students.
6. Tertiary institutions should incorporate real-world problem-solving activities into the STEM curriculum. When students can see the practical applications of their studies, they are more likely to stay engaged and motivated.
7. STEM programs should consider adopting more flexible assessment strategies that allow students to learn from their mistakes. Instead of solely relying on high-stakes exams, formative assessments, continuous feedback, and opportunities to revise and improve work can help students develop resilience. This approach encourages students to view failure as part of the learning process, rather than as an endpoint, making them more likely to persist in their studies.
8. Tertiary institutions should actively work to create a culture of resilience within their STEM departments. This can be achieved through leadership initiatives, faculty training on resilience-building practices, and the development of policies that prioritize student well-being and success. Administrators should foster an environment where failure is normalized as part of the learning process, and resilience is celebrated as a key component of academic and professional success in STEM.

By implementing these recommendations, tertiary institutions can better equip STEM students with the resilience they need to succeed in their academic journeys and future careers, ultimately strengthening the global STEM workforce.

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