

NAVIGATING LEARNING IN THE MIDST OF POLYCRISIS: EXPLORING THE IMPLEMENTATION OF RESILIENCE-BUILDING STRATEGIES TO REDUCE SCIENCE ANXIETY, IMPROVE SELF-EFFICACY AND ENHANCE LONG-TERM STEM PERFORMANCE FOR SUSTAINABILITY

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Abstract

This study explores the implementation of resilience-building strategies to reduce science and mathematics anxiety, strengthen self-efficacy, and enhance long-term STEM performance among preservice teachers in a historically disadvantaged institution of higher learning. Situated within the broader context of global and local polycrisis, characterised by socio-economic inequality, educational disparities, and systemic marginalisation, the project responds to persistently high levels of science and mathematics anxiety among students from rural and low socio-economic backgrounds. Grounded in resilience theory and social justice-oriented pedagogy, a qualitative case study design was employed. A structured professional development programme was implemented to support STEM lecturers in integrating resilience-informed and inclusive teaching practices into their classrooms. Data were generated through semi-structured interviews with lecturers and students, reflective journals, focus group discussions, and classroom observations. Thematic analysis was used to explore participants' lived experiences of anxiety, coping, and pedagogical transformation. Findings reveal that creating humanising, dialogic classroom spaces enabled students to openly articulate their anxieties and to reconstruct their identities as capable science and mathematics students. Participants described shifts from fear and avoidance toward increased confidence, persistence, and active engagement. Lecturers reported greater awareness of students' socio-emotional realities and intentionally adapted their teaching to connect scientific knowledge to students' lived experiences. The study recommends embedding resilience-informed pedagogy within lecturer professional development programmes, institutionalising socio-emotional support structures in STEM curricula, and advancing equity-driven policies that recognise the structural roots of science and mathematics anxiety.

Keywords: *Science anxiety, mathematics anxiety, resilience, polycrisis, STEM education, sustainability, social justice.*

1. Introduction

Higher education institutions globally are confronting what Morin (2020) describes as a polycrisis, a convergence of economic instability, social inequality, environmental uncertainty, and institutional disruption. In South Africa, these challenges are intensified by the enduring effects of apartheid-era inequalities that continue to shape access to quality science and mathematics education (Spaull, 2013).

Science and mathematics anxiety are widely recognised barriers to students' participation and success in STEM disciplines. Science anxiety refers to feelings of fear and tension that interfere with scientific learning and performance (Mallow, 2006), while mathematics anxiety involves emotional responses that disrupt numerical reasoning and problem solving (Ashcraft & Krause, 2007). These anxieties are particularly pronounced among students from historically marginalised communities who may have experienced under-resourced schooling, language barriers, and reduced narratives about intellectual capability. Resilience theory provides a useful lens for addressing these challenges. Resilience refers to the capacity to adapt successfully in the face of adversity (Masten, 2014). Within STEM education, fostering resilience can enable students to engage productively with conceptual difficulty, develop academic self-efficacy, and persist in challenging learning environments. This study, therefore, explores how resilience-building pedagogical strategies implemented by lecturers can reduce anxiety and strengthen preservice teachers' engagement with STEM disciplines.

2. Literature review

Science and mathematics anxiety function as affective barriers that hinder students' engagement, performance, and persistence in STEM fields (Mallow, 2006; Ashcraft & Krause, 2007). Anxiety affects cognitive resources such as working memory, thereby limiting students' ability to process complex information during learning and assessment tasks (Ashcraft & Krause, 2007). In contexts marked by historical marginalisation, these anxieties intersect with broader issues of access, identity, and belonging (Carlone & Johnson, 2007). Students who perceive STEM fields as elitist or exclusionary may internalise the belief that they do not belong in these disciplines.

The concept of polycrisis further highlights how overlapping social and institutional challenges intensify vulnerability within educational spaces (Morin, 1999). For students in historically disadvantaged institutions, such pressures often undermine self-efficacy and reinforce avoidance behaviours in STEM learning.

Resilience has increasingly been conceptualised as an individual trait and also as a dynamic process shaped by supportive environments and social relationships (Masten, 2014; Ungar, 2011). In educational contexts, resilience manifests through persistence, adaptive coping strategies, and the ability to navigate academic challenges without internalising failure.

Social justice-oriented pedagogy complements resilience theory by addressing structural inequalities within learning environments. Freire (1970) criticises traditional "banking models" of education that position students as passive recipients of knowledge. Instead, he advocates dialogic and participatory pedagogies that recognise students' lived experiences as legitimate sources of knowledge. Research on science identity similarly emphasises that recognition, competence, and performance are central to students' persistence in STEM fields (Carlone & Johnson, 2007). Inclusive classroom environments that validate students' contributions can therefore play a critical role in reducing anxiety and fostering a sense of belonging.

3. Theoretical framework

Resilience theory has evolved toward ecological understandings that emphasise the interaction between individual agency and supportive social systems (Masten, 2014; Ungar, 2011). Masten (2014) famously describes resilience as "ordinary magic," highlighting that adaptive capacity often emerges from everyday protective systems such as supportive relationships and positive expectations. In STEM learning contexts, resilience becomes particularly important because mastering scientific concepts often involves encountering difficulties and failures. When struggle is normalised as part of disciplinary learning, students are more likely to interpret challenges as opportunities for growth rather than evidence of incompetence (Dweck, 2006).

Resilience theory also aligns with Bandura's (1997) concept of self-efficacy, which emphasises that individuals' beliefs about their capabilities influence motivation, persistence, and performance. While resilience theory explains how students adapt to challenges, social justice pedagogy examines the structural inequalities that produce those challenges. Freire (1970) argues that education should empower learners through dialogic engagement and recognition of their lived experiences. In STEM education, traditional pedagogies often privilege abstract knowledge detached from students' socio-cultural contexts (Archer et al., 2015). Social justice-oriented teaching, therefore, seeks to validate diverse forms of knowledge and reposition students as legitimate contributors to scientific learning.

4. Methodology

4.1. Research design and participants

The study employed a qualitative case study design (Yin, 2018). Participants included:

- Six STEM lecturers are involved in a resilience-informed professional development programme,
- Thirty preservice teachers enrolled in mathematics and science methods courses.

Purposive sampling ensured that participants were directly involved in the pedagogical intervention (Creswell & Poth, 2018).

4.2. Intervention

The intervention consisted of professional development workshops designed to support lecturers in integrating resilience-informed teaching strategies. Workshop topics included:

- Understanding science and mathematics anxiety
- Creating dialogic and humanising classrooms
- Integrating students' lived experiences into STEM teaching

- Developing strategies for coping with academic stress
- Following the workshops, lecturers implemented resilience-building practices in their classrooms for one academic semester.

4.3. Data collection and analysis

Multiple qualitative methods were used to ensure methodological triangulation (Lincoln & Guba, 1985):

- Semi-structured interviews
- Focus group discussions
- Classroom observations
- Reflective journals

Data were analysed using reflexive thematic analysis (Braun & Clarke, 2006) informed by resilience theory and social justice pedagogy.

5. Findings

Five interrelated themes emerged from the analysis.

Theme 1: Reframing Struggle as Growth

Students initially associated science and mathematics with fear and embarrassment. One student explained:

“In high school, if you got the answer wrong, it felt like you were exposed. So, I learned to just keep quiet.” (student 4).

After the intervention, students began to reinterpret difficulty as part of the learning process.

“Now when I don’t understand something immediately, I don’t panic. I tell myself this is part of learning science.” (student 9).

Lecturers reinforced this shift by explicitly normalising confusion and mistakes during classroom discussions.

Theme 2: Relational Safety and Dialogic Space

A key factor in reducing anxiety was the creation of respectful and supportive classroom relationships. Students emphasised the importance of feeling heard:

“Before, I felt like science was for clever people only. But here, the lecturer listens. Even when you say something small, it is valued.” (student 1).

Lecturers reported intentionally adopting more dialogic teaching practices.

“I realised I was rushing through content before. Now I pause and ask students what they think... It changed the atmosphere completely.” (Lecturer 5).

Theme 3: Recognition and Identity Reconstruction

Many students entered the programme believing they were incapable of succeeding in STEM.

“I always believed I was just not a science person.” (student 12).

Through affirming feedback and inclusive engagement, lecturers helped students reconstruct their academic identities.

“When my lecturer said, ‘That’s a strong scientific explanation,’ I was shocked. No one had ever said that to me before.” (student 3).

Theme 4: From Silence to Participation

Prior to the intervention, students often avoided speaking in class due to fear of embarrassment.

“If the lecturer asked a question, my heart would beat fast. I would just look down.” (student 20).

Following the intervention, participation increased significantly.

“Now I raise my hand, even if I’m not 100% sure. I know I won’t be laughed at.” (student 16).

Lecturers similarly observed greater engagement among previously silent students.

Theme 5: Pedagogical Reflexivity

Lecturers reported increased awareness of the socio-emotional dimensions of STEM learning.

“I used to think anxiety was a personal weakness. Now I see how our teaching can either increase or reduce it.” (Lecturer 2).

These reflections prompted changes in teaching practices, including slower pacing, contextualised examples, and emotional check-ins with students.

6. Discussion

The findings demonstrate that resilience-building strategies embedded within socially just pedagogy can significantly reduce STEM anxiety and improve student engagement. Reframing struggle as a normal part of scientific learning aligns with resilience theory's emphasis on adaptive functioning within supportive environments (Masten, 2014).

The establishment of relationally safe classrooms also supports Freire's (1970) notion of dialogic pedagogy, where students are recognised as co-constructors of knowledge. Recognition played a particularly important role in reshaping students' science identities, consistent with the framework proposed by Carlone and Johnson (2007).

Moreover, the shift from silence to participation indicates strengthened self-efficacy beliefs (Bandura, 1997). Participation became possible because classroom environments reduced the relational risks associated with making mistakes. Importantly, the study highlights that resilience is not solely an individual attribute but emerges through supportive educational systems and inclusive pedagogical practices (Ungar, 2011).

7. Conclusion and recommendations

This study demonstrates that resilience-building strategies embedded within social justice-oriented pedagogy can meaningfully reduce science and mathematics anxiety among preservice teachers. Anxiety was shown to be a relational and structurally mediated experience shaped by classroom culture, recognition, and pedagogical practices.

The findings suggest that improving STEM participation requires more than cognitive skill development. It requires transforming teaching practices and institutional cultures to support student belonging and confidence. The study therefore recommends:

- Integrating resilience-informed pedagogies into lecturer professional development programmes.
- Embedding socio-emotional learning within STEM curricula.
- Developing institutional policies that address the structural roots of STEM anxiety.
- Creating supportive learning environments that affirm students' identities and lived experiences.

Such initiatives can contribute to more equitable and sustainable participation in STEM education, particularly within historically disadvantaged higher education contexts.

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