

A QUALITATIVE INQUIRY INTO TRANSGRESSIVE PEDAGOGICAL PRACTICES AND THEIR ROLE IN ADDRESSING ANXIETY AND SOCIAL INEQUALITY IN STEM EDUCATION

Sakiwaa Boateng

Faculty of Education, Walter Sisulu University, Mthatha (South Africa)

Abstract

Anxiety in Science, Technology, Engineering, and Mathematics (STEM) remains a persistent challenge within higher education, disproportionately affecting students from historically marginalised and under-resourced educational contexts. Such anxiety undermines students' confidence and academic performance and further reinforces existing social inequalities and barriers to meaningful participation in STEM fields. This qualitative inquiry examines the implementation of transgressive pedagogical practices as an intervention strategy to alleviate STEM-related anxiety and nurture resilience among preservice teachers at a South African institution of higher learning. The study was grounded in a transformative, social justice-oriented pedagogical theory, engaging STEM lecturers in a structured professional development programme that trained them to integrate coping strategies into their teaching practice as forms of transgressive pedagogy. The intervention unfolded through a series of workshops designed to create awareness of preservice teachers' lived experiences of STEM anxiety. Participants were encouraged to openly share their fears, academic struggles, and past negative encounters with STEM subjects, creating a safe and humanising learning space that disrupted traditional power dynamics within teacher education. Data were generated through reflective journals, focus group discussions, workshop artefacts, and semi-structured interviews. Using thematic analysis, the findings reveal that transgressive pedagogy promotes emotional safety, strengthens academic identity, and promotes agency among preservice teachers. Participants reported increased confidence, improved coping capacity, and a shift from a self-doubt-oriented perspective to one rooted in possibility, confidence, and sustained resilience. The study, therefore, contributes to a more equitable and inclusive teaching and learning culture in higher education. Implications for teacher education, curriculum transformation, and long-term STEM participation are discussed.

Keywords: *Anxiety, resilience, social justice, transgressive pedagogy.*

1. Introduction

Science, Technology, Engineering, and Mathematics (STEM) education remains a critical driver of economic development and social mobility globally. However, persistent inequalities and high levels of academic anxiety continue to limit equitable participation in STEM, particularly among students from historically marginalised and under-resourced educational backgrounds (Archer et al., 2015). In the South African context, structural inequalities rooted in apartheid-era schooling systems continue to shape students' access to quality STEM education (Spaull, 2013). These disparities often manifest as low confidence, poor conceptual foundations, and increased anxiety in STEM subjects.

Anxiety undermines students' academic performance, limits classroom participation, and erodes professional identity formation, particularly among preservice teachers preparing to teach STEM subjects (Bursal & Paznokas, 2006).

Transgressive pedagogy, rooted in social justice and transformative educational theory, challenges oppressive classroom structures and disrupts hierarchical power dynamics (Hooks, 1994; Giroux, 1988). Rather than reproducing dominant knowledge systems, it humanises learning spaces and centres students' lived experiences as legitimate sources of knowledge. This study explores how transgressive pedagogical practices can be used as an intervention strategy to address STEM anxiety and mitigate social inequality among preservice teachers at a South African institution of higher learning. Therefore, this study seeks to answer the following research question:

- How do transgressive pedagogical practices contribute to alleviating STEM-related anxiety and promoting resilience among preservice teachers from historically marginalised backgrounds?

2. Literature review

2.1. STEM anxiety and social inequality

STEM anxiety refers to feelings of tension, fear, and apprehension that interfere with engagement and performance in science-related tasks (Mallow, 2006). Research indicates that anxiety is closely linked to prior schooling experiences, teacher attitudes, and social stereotypes about who belongs in STEM (Beilock et al., 2010). Students from under-resourced educational contexts often enter higher education with limited exposure to laboratory resources, inquiry-based learning, and supportive pedagogies, increasing their vulnerability to anxiety (Archer et al., 2015).

In South Africa, educational inequality remains pronounced, with learners from rural and township schools experiencing systemic disadvantages (Spaull, 2013). Such inequalities translate into epistemic marginalisation in higher education, where dominant pedagogical approaches may privilege students already socialised into academic STEM discourse (Luckett & Shay, 2020).

2.2. Resilience and academic identity

Resilience in educational settings refers to students' capacity to adapt positively despite adversity (Ungar, 2011). In STEM education, resilience is fostered through supportive relationships, positive feedback, and opportunities for mastery experiences (Bandura, 1997). When students develop a strong academic identity in STEM, they are more likely to persist despite challenges (Carlone & Johnson, 2007).

However, traditional pedagogies often neglect the emotional dimensions of learning, reinforcing performance-based identities rather than growth-oriented identities (Dweck, 2006). Addressing anxiety, therefore, requires pedagogical strategies that explicitly acknowledge students' emotional experiences.

2.3. Transgressive pedagogy in higher education

Transgressive pedagogy, as articulated by Hooks (1994), invites educators to move beyond rigid, authoritarian models of teaching and toward dialogic, participatory, and humanising practices. It disrupts the "banking model" of education (Freire, 1970) and positions learning as a collaborative process.

Within STEM contexts, transgressive practices may include reflective dialogue, collaborative problem-solving, vulnerability modelling by lecturers, and explicit discussion of anxiety as a shared experience (Zembylas, 2015). Such approaches challenge the myth of objectivity and emotional neutrality often associated with STEM disciplines.

2.4. Theoretical framework

This study is grounded in transformative learning theory (Mezirow, 1991) and critical pedagogy (Freire, 1970; Giroux, 1988). Transformative learning emphasises critical reflection on assumptions, leading to shifts in meaning perspectives. In this study, preservice teachers critically reflected on internalised beliefs about their STEM abilities.

Critical pedagogy foregrounds issues of power, inequality, and emancipation. Transgressive pedagogy, emerging from this tradition, actively challenges structures that reproduce inequality (Hooks, 1994). By integrating coping strategies into STEM instruction, lecturers enacted a socially responsive pedagogy that acknowledged emotional labour as integral to learning.

3. Methodology

The study adopted an interpretivist paradigm, recognising knowledge as socially constructed (Creswell & Poth, 2018). A qualitative research design was employed to explore participants' lived experiences of STEM anxiety and their engagement with transgressive pedagogical practices. Participants included 18 preservice teachers enrolled in a STEM education module at a South African university, along with four STEM lecturers who participated in a professional development programme. The programme consisted of structured workshops focusing on integrating coping strategies and dialogic practices into teaching.

3.1. Data generation

Data were generated through:

- Reflective journals (n = 18)
- Semi-structured interviews with lecturers and students.
- Classroom observations.

3.2. Data analysis

Thematic analysis was conducted following Braun and Clarke's (2006) six-phase framework. Codes were generated inductively and refined into themes representing shared patterns of meaning.

4. Findings

Three major themes emerged from the data: (1) Emotional Safety as Pedagogical Disruption, (2) Reconstructing Academic Identity, and (3) Agency and Resilience Building.

Theme 1: Emotional safety as pedagogical disruption

Participants described traditional STEM classrooms as intimidating and performance driven. One participant shared:

"In high school, asking a question in physics felt like exposing your stupidity. Here, for the first time, I felt like my confusion was normal" (SST2)

Lecturers intentionally disrupted hierarchical norms by sharing their own struggles. A lecturer noted:

"When I told them about failing my first chemistry test, I saw their posture change. It was like permission to be human" (SL1).

Creating safe dialogic spaces reduced fear of judgment and normalised vulnerability. This finding was also evident in the classroom during lectures.

Theme 2: Reconstructing academic identity

Participants reported a shift from self-doubt to confidence. One journal entry read:

"I used to say, 'I'm just not a science person.' Now I realise that was a story I inherited" (SST10).

Through reflective exercises, preservice teachers reframed their academic identities. Mastery experiences embedded within collaborative tasks strengthened self-efficacy.

The classroom observation indicated that student worked collaboratively with each other to complete a task.

Theme 3: Agency and Resilience Building

Participants described gaining tools to cope with anxiety:

"Breathing techniques before tests and talking through problems in groups made a big difference" (SST4).

Resilience emerged not as individual toughness but as relational support. Participants reported feeling empowered to adopt similar strategies in their future classrooms. Lecturers indicated that students' autonomy was enhanced through the activities presented in class. This was evident during the classroom observation.

5. Discussion

The findings affirm that STEM anxiety is socially embedded rather than purely cognitive. Transgressive pedagogy functioned as a counter-hegemonic practice that disrupted deficit narratives and fostered a sense of belonging. Emotional safety enhanced self-efficacy (Bandura, 1997), while dialogic engagement facilitated transformative learning (Mezirow, 1991).

Importantly, resilience was cultivated through collective practices rather than individualised coping mechanisms, aligning with Ungar's (2011) socio-ecological understanding of resilience. By centring lived experiences, the intervention addressed structural inequalities embedded in traditional STEM teaching.

6. Conclusion and recommendations

This study demonstrates that transgressive pedagogical practices offer a promising framework for addressing STEM anxiety and social inequality in higher education. By humanising the classroom, disrupting power hierarchies, and integrating coping strategies into instruction, educators can promote confidence, agency, and resilience among preservice teachers.

6.1. Recommendations

The findings of this study highlight several important recommendations for strengthening inclusive and supportive STEM education practices. First, there is a need for stronger institutional support for professional development. Universities should provide structured, ongoing training for lecturers in socially responsive STEM pedagogy to equip educators with the skills and awareness to recognise and respond to students' emotional and academic challenges related to STEM anxiety. In addition, curriculum transformation is essential. Emotional literacy and coping strategies should be deliberately embedded in STEM modules to support students.

Furthermore, future research should adopt a longitudinal perspective to better understand the sustained impact of these pedagogical interventions. Long-term studies could examine how resilience-building and emotionally responsive teaching practices influence preservice teachers' classroom practices, professional identity development, and continued participation in STEM-related fields. Finally, policy frameworks in teacher education should be aligned with these pedagogical priorities. Educational policies should explicitly recognise emotional well-being as a critical component of academic success and teacher preparation.

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