Research Article

e-ISSN: 2710-2122, p-ISSN: 2710-2114
2025: Vol 7(1), pp 1-20. https://doi.org/10.38140/ijer-2025.vol7.1.26
Interdisciplinary Journal of Education Research

Decolonising Mathematics Education: Towards A Culturally Relevant Pedagogy

Babawande E. Olawale[1*]

AFFILIATIONS

[1]Faculty of Education, Walter Sisulu University, Komani, South Africa.

CORRESPONDENCE

Email: bolawale@wsu.ac.za*

EDITORIAL DATES
Received: 24 February 2025
Revised: 10 May 2025
Accepted: 29 May 2025
Published: 05 July 2025

DOI: 10.38140/ijer-2025.vol7.1.26

Abstract: This study investigates the existence of Eurocentric biases in mathematics teacher education programmes within South African higher education, focusing on the experiences and viewpoints of mathematics lecturers, mathematics student teachers, and department heads. It seeks to fill gaps in understanding how these biases impact educational practices and how the incorporation of culturally responsive pedagogy can eliminate them. Underpinned by an interpretivist paradigm, this study employed a qualitative research approach and a case study design. A purposive sampling technique was used to select two mathematics lecturers, ten mathematics student teachers in their fourth year of study, and a head of department, resulting in a total of thirty-nine samples from three purposively selected traditional universities across two provinces in South Africa. Thematic analysis was used to examine data gathered from semi-structured interviews, observational notes, and documents. Thematic coding was performed inductively, leading to the identification of principal themes that represent participants' perspectives. Findings reveal a significant recognition of Eurocentric biases in mathematics education, with participants expressing concerns about the lack of culturally relevant content and pedagogical approaches. Based on the findings, the study concludes that addressing these biases is crucial for fostering inclusive educational environments and enhancing the effectiveness of culturally responsive teaching in mathematics. It underscores the need for mathematics teacher education programmes to align their curricula with the diverse cultural contexts of South Africa, promoting social justice and equity in mathematics education.

Keywords: Critical consciousness, culturally relevant pedagogy, Eurocentricism, non-Western contributions, social justice.

1. Introduction

Mathematics is frequently regarded as a global language; however, it has traditionally been contextualised within Eurocentric frameworks that favour Western techniques and epistemologies. This dominance has led to a limited comprehension of mathematics that neglects the rich and diverse mathematical traditions and practices of other cultures (Aikenhead, 2017; Parra & Trinick, 2018). The ramifications of this Eurocentrism are significant, as they determine the methodology of mathematics education and affect students' identities, self-efficacy, and involvement with the discipline (White et al., 2019; Bullock, 2024). The concept of transformational pedagogy is based on the premise that education should not only convey knowledge but also cultivate critical consciousness and promote social justice (Santamaría & Jean-Marie, 2014). Thus, Freire (1970, 1998) posits that education is a liberating practice that empowers individuals to interrogate and contest repressive societal structures. In mathematics education, this entails acknowledging the historical and cultural backgrounds of mathematical knowledge and practices while actively striving to dismantle the hierarchical structures that exclude non-Western mathematical contributions. By implementing a transformative pedagogical approach, educators can establish an inclusive learning environment that appreciates multiple mathematical perspectives and fosters fairness in mathematics education (Olawale, 2021, 2022, 2025).

How to cite this article:
Olawale, B. E. (2025). Decolonising mathematics education: Towards a culturally relevant pedagogy. *Interdisciplinary Journal of Education Research, 7*(1), a26. https://doi.org/10.38140/ijer-2025.vol7.1.26

In South Africa, the educational landscape is marked by a legacy of inequality and exclusion, particularly within higher education institutions (Gyamera & Burke, 2018; Mudaly, 2018) and teacher education programmes (Mudaly, 2018; Olawale, 2021, 2023, 2025). The curricula often reflect Western ideals and methodologies (Gyamera & Burke, 2018; Zembylas, 2018), which do not resonate with students' cultural identities and lived experiences. This disconnect alienates students from diverse backgrounds, leading to disengagement and a lack of confidence in their mathematical abilities. Similarly, numerous teacher education programmes in South Africa display a Eurocentric bias that disregards local knowledge systems and cultural contexts, despite the rich tapestry of cultural diversity in the country's higher education landscape (Mavuso, Olawale, & Mkosi, 2021; Kolovou, 2023). According to Mudaly (2018) and Kolovou (2023), this prejudice does more than render classes less relevant to pre-service mathematics teachers in the teacher education programmes within South African higher education institutions; it also prevents them from making connections between what they learn in class and their real-life experiences. Hence, there is a need for culturally appropriate pedagogy in mathematics education, which confronts these ingrained prejudices and promotes a more inclusive and meaningful interaction with mathematics (Ladson-Billings, 2021; Olawale, 2025). Nonetheless, despite the increasing acknowledgement of the significance of culturally relevant practices, a substantial gap persists in the literature concerning their integration and impact on student learning outcomes and attitudes in mathematics teacher education programmes within South African higher education institutions. Thus, this study addresses this gap by exploring how culturally relevant pedagogy can be integrated to challenge Eurocentric biases, thereby empowering student teachers to engage with mathematics in ways that resonate with their cultural identities and lived experiences. Through this exploration, the study seeks to provide insights and recommendations for educators and policymakers to enhance inclusivity in teaching practices and promote curriculum reforms that reflect a broader spectrum of cultural knowledge within mathematics teacher education programmes.

2. Literature Review

This literature review examines the role of culturally relevant and transformative pedagogy in mathematics education. It explores how inclusive approaches challenge traditional Eurocentric methods while promoting equity and engagement.

2.1 Culturally relevant pedagogy in mathematics education

According to Ladson-Billings (1995), culturally relevant education requires instructors to link academic curricula with students' cultural backgrounds and experiences. In mathematics, this involves incorporating culturally meaningful mathematical practices and histories into the curriculum, affirming students' identities and cultivating a sense of belonging in the classroom (Ladson-Billings 1995, 2021). Integrating indigenous counting systems, traditional geometric methods, or culturally specific problem-solving techniques can enable pupils to recognise the significance of mathematics in their lives and communities. This approach increases students' engagement with mathematics and fosters a deeper comprehension of the subject as a dynamic and evolving field (Ladson-Billings, 2023; Olawale et al., 2025). Consequently, the demand for transformative and culturally pertinent pedagogies in mathematics education is particularly urgent in today's increasingly diverse classrooms. As demographic changes continue to transform the student population across many nations, educators face the challenge of addressing the needs of pupils from diverse cultural and linguistic backgrounds (Sleeter et al., 2014; Gay, 2015). Studies indicate that students who perceive their cultural identities represented in the curriculum are more inclined to achieve academic success and develop a favourable disposition towards learning (Murrell, 2017; Gay, 2018; Kumar, 2018; Warren, 2018; Alam & Mohanty, 2023; Olawale, 2023; Olawale, 2025). Consequently, it is essential for mathematics education to transcend a uniform approach and incorporate diverse cultural viewpoints that can enhance the learning experience.

Furthermore, the incorporation of transformative pedagogy in mathematics teaching aligns with the overarching educational objectives of cultivating critical thinking, problem-solving abilities, and social responsibility in pupils (Olawale et al., 2022). In a time characterised by intricate global issues such as climate change, social injustice, and technological progress, the capacity for critical thinking and meaningful engagement with mathematical concepts is of paramount importance (Bray & Tangney, 2016; Maass et al., 2019; Attard & Holmes, 2020; Skovsmose, 2020). Thus, educators can equip students with the skills required to navigate an increasingly complex world by encouraging them to challenge the status quo, scrutinise facts, and employ mathematical reasoning in real-world scenarios. Nonetheless, the implementation of transformative pedagogy in mathematics education presents several challenges. Educators may face opposition from traditional educational frameworks, standardised assessment methods, and deeply rooted beliefs regarding the nature of legitimate mathematical knowledge. Moreover, there may be insufficient resources, training, and support for educators aiming to use culturally relevant instructional techniques (Goos, 2020; Alam & Mohanty, 2023; Giroux, 2024). It is therefore imperative to offer professional development opportunities and establish collaborative networks that enable educators to explore and apply revolutionary pedagogies in their classrooms. Hence, this study examines transformative pedagogy in mathematics education that challenges Eurocentric biases and provides ways to empower students to engage with mathematics in culturally relevant ways.

2.2 Critique of traditional mathematics education

Traditional mathematics education has typically featured a Eurocentric curriculum that emphasises Western mathematical concepts and methodologies, often sidelining the contributions and viewpoints of non-Western cultures. Lubienski (2000) observes that the dominant mathematics curriculum in numerous Western nations often embodies a limited perspective on mathematical knowledge, thereby alienating pupils from diverse backgrounds. This Eurocentric bias restricts students' involvement in mathematics and sustains structural inequities within educational systems (Skovsmose, 1994). Research has underscored the adverse effects of a Eurocentric curriculum on students' identities and their sense of belonging in mathematics (Aikenhead, 2017; Stinson et al., 2024). Consequently, Martin (2010) contends that pupils of colour frequently encounter a disconnect from mathematics due to insufficient representation and relevance within the curriculum. This dissociation may result in reduced levels of accomplishment and a waning interest in mathematics-related disciplines. Moreover, the focus on rote memorisation and standardised assessments in conventional mathematics education has been criticised for inhibiting creativity and critical thinking (Kohn, 2000; Kim, 2005; Ernest, 2010; Noddings & Brooks, 2016; Olawale et al., 2021; Olawale et al., 2025). In light of these critiques, experts advocate for a reassessment of mathematics education that incorporates multiple cultural perspectives and acknowledges the extensive mathematical traditions inherent in various cultures (Bishop, 1988). By including culturally pertinent topics, educators can foster a more inclusive atmosphere that affirms students' identities and experiences, thereby improving their engagement and achievement in mathematics.

2.3 Principles of transformative pedagogy

Transformative pedagogy is rooted in critical theory and seeks to empower learners by cultivating critical consciousness and promoting social justice (Freire, 1970). In the realm of mathematics education, transformative pedagogy aims to challenge conventional practices and encourage the perception of mathematics as a socially constructed field intricately linked to cultural contexts (Gutstein & Peterson, 2005; Moss & Faux, 2006; Gutstein, 2007; Olawale et al., 2021). A fundamental concept of transformative pedagogy is the recognition of students' lived experiences as significant sources of knowledge. Consequently, Ladson-Billings (1995) posits that culturally relevant teaching underscores the necessity of connecting academic material to students' cultural contexts, thereby validating their identities and promoting a sense of agency. This approach enhances student

engagement and fosters the perception of mathematics as a means to understand and address real-world problems (Olawale, 2022; Nilimaa, 2023). Moreover, transformative pedagogy advocates for collaborative learning environments that facilitate dialogue and critical thinking among students. Thus, Vygotsky (1978)'s social constructivist theory emphasises the importance of social interaction in learning, positing that students develop knowledge through collaborative experiences. Incorporating collaborative work and discussions into mathematics instruction enables educators to enhance students' comprehension of mathematical concepts while nurturing critical thinking and problem-solving abilities (Webb, 2019; Jablonka, 2020; Nilimaa, 2023). Furthermore, the inclusion of social justice topics in mathematics education is a fundamental principle of transformative pedagogy. Similarly, Gutstein (2007) illustrates the application of mathematics in analysing and addressing social challenges, including poverty and inequality. By positioning mathematics as a tool for social critique, educators can empower students to utilise their mathematical expertise to advocate for change within their communities. This approach aligns with the tenets of culturally relevant teaching, which emphasises the importance of cultivating critical consciousness in students (Ladson-Billings, 1995; Grossberg, 1996).

2.4 Research question

The study provided an answer to the following piloting research question:

- How can culturally relevant pedagogy challenge Eurocentric biases in mathematics curricula and empower students to engage with mathematics in meaningful ways?

3. Methodology

This section outlines the methodological framework adopted to explore culturally relevant pedagogy in mathematics education. It details the research paradigm, approach, design, participant selection, data collection, analysis procedures, and ethical considerations, ensuring the study's rigour, depth, and credibility.

3.1 Research paradigm

This study is underpinned by an interpretivist paradigm, which posits that individuals derive meaning from their actual experiences through interactions with their surroundings (Thanh & Thanh, 2015; Gichuru, 2017). The interpretivist paradigm aims to provide profound insights into the intricate realm of lived experiences, as articulated by those who have undergone such experiences (Gichuru, 2017). This paradigm was deemed appropriate for this study because it emphasises the importance of context in understanding the phenomenon under investigation. This approach facilitates a deep understanding of participants' experiences, ultimately contributing to the creation of a more equitable and meaningful teacher education programme.

3.2 Research approach and design

According to Creswell and Creswell (2017), a research approach is a systematic framework and process that progresses from general hypotheses to specific techniques for data collection, analysis, and interpretation. Although numerous research strategies, including quantitative, qualitative, and mixed methods, are available, this study employed a qualitative research approach as the most appropriate choice (Creswell & Poth, 2016; Creswell & Creswell, 2017). Christou (2015) notes that a qualitative approach emphasises the why and how behind a phenomenon rather than the what or how many. Consequently, this approach was deemed suitable for the study as it allowed the researcher to explore the complexities of contexts and lived experiences associated with culturally relevant pedagogy and Eurocentric biases in mathematics curricula.

Research design involves the methodical integration of various study aspects to effectively address the research issue (De Vaus & de Vaus, 2013). For this study, a case study design was employed.

According to Yin (2014), a case study investigates a phenomenon within its real-life context, particularly when it is challenging to differentiate the phenomenon from its surroundings and when multiple data sources are used. Consequently, as participants were selected from various backgrounds (i.e., different universities from different provinces, diversity of language and culture, student demographics, and institutional supports and resources) and had a variety of experiences with their teacher education programmes, a multiple case study design was adopted. This design was deemed appropriate for the study because it includes diverse perspectives from various participants, enabling a comprehensive understanding of the phenomenon under investigation.

3.3 Study participants

This study's participants comprised mathematics lecturers, mathematics student teachers, and heads of departments in science education departments of three selected traditional universities (institutions that offer a broad range of academic programmes, both undergraduate and postgraduate, and are considered academic) across two provinces in South Africa. To gather fresh and intriguing data on how culturally relevant pedagogy can be integrated to challenge Eurocentric biases in mathematics curricula and empower students to engage with mathematics in meaningful ways, the researcher purposively chose three South African traditional universities that offer a Bachelor of Education (B.Ed.) degree. Furthermore, the three universities were purposively selected based on the universities' diverse student body, which includes underrepresented cultural and ethnic groups with existing culturally relevant programmes, thus offering a rich context for the study. At each of the three South African universities, the sample comprised two (2) mathematics lecturers chosen for their dedication to transformative teaching and their readiness to participate in the research process, ten (10) mathematics student teachers in their fourth year of study, and one (1) head of department, which was included to offer perspectives on the wider social and cultural context of mathematics instruction. Thus, a total sample of thirty-nine (39) individuals was selected through purposive sampling to guarantee a diverse representation of viewpoints. The selection criteria encompassed diversity in cultural backgrounds, academic achievement, and degrees of participation in mathematics.

3.4 Data collection

Data gathering procedures were developed to comprehensively understand participants' experiences and viewpoints. This study involved semi-structured interviews with mathematics lecturers, mathematics student teachers, and heads of department to explore their experiences in mathematics education, their views on Eurocentric biases, and their engagement with culturally relevant practices. Interviews ranged from 30 to 60 minutes in duration and were audio-recorded with the participants' consent. Classroom observations were conducted to document the implementation of culturally relevant mathematics lessons. Observational notes were taken during lessons to record interactions between mathematics lecturers and student teachers, as well as the use of materials and resources that reflected the students' cultural backgrounds. This approach provided insight into the alignment between educators' objectives and their actual classroom practices.

3.5 Data analysis

The data analysis procedure encompassed multiple steps to evaluate the gathered data comprehensively. Thematic analysis was utilised to discern patterns and themes within the various data sources, with the data collected being evaluated using the data analysis technique outlined by Clarke et al. (2015). Firstly, transcription was carried out. Audio-recorded interviews and focus groups were transcribed verbatim to produce a textual representation of the data. The transcriptions were assessed for precision, and participants had the opportunity to provide feedback or clarification. Secondly, data were coded. At this stage, the transcribed data, observational notes, and document analyses were subjected to an open coding methodology. Initial codes were constructed

inductively, facilitating the emergence of themes from the data rather than imposing pre-existing categories (Clarke et al., 2015). In the third step, themes were developed. Following coding, the data were categorised into overarching themes that encapsulated the core of participants' experiences and viewpoints. Themes were refined through a cyclical process of evaluation and modification, ensuring they authentically represented the participants' perspectives. In the fourth stage, member checking was conducted to enhance the trustworthiness of the findings by disseminating early themes and interpretations to participants. Their input corroborated the findings and offered supplementary insights. Lastly, the concluding phase involved amalgamating the concepts into a cohesive narrative that underscored the transformative potential of culturally responsive teaching in mathematics education (Clarke et al., 2015). The synthesis aimed to demonstrate the interrelation of the themes and their implications for practice and policy.

3.6 Ethical considerations

For this study, informed consent was obtained from all individuals prior to their participation. Participants were assured that they could withdraw from the study at any time without repercussions. Confidentiality was maintained by assigning pseudonyms to participants and removing identifying information from all data sources. The Inter-Faculty Research Ethics Committee (IFREC) of the University of Fort Hare in the Eastern Cape Province, South Africa, reviewed and approved the study to ensure compliance with ethical research standards, and ethical clearance was granted for the study under protocol number MNC021SOLA01.

4. Presentation of Results

To identify the Eurocentric biases in mathematics curricula, data were collected, analysed, and categorised based on emerging themes. The three participating schools were anonymised to protect the identities of the participants and the institutions. Table 1 below shows the codes for the respective participants:

Table 1: *Codes for the study participants*

Participants	codes for the study participants
Mathematics Lecturer – University A	ML 1; ML 2 – University A
Mathematics Lecturer – University B	ML 1; ML 2 – University B
Mathematics Lecturer – University C	ML 1; ML 2 – University C
Mathematics Student Teachers – University A	MST 1; MST 2 …….MST 10 – University A
Mathematics Student Teachers – University B	MST 1; MST 2 …….MST 10 – University B
Mathematics Student Teachers – University C	MST 1; MST 2 …….MST 10 – University C
Head of Department 1 – University A	H.O.D 1 – University A
Head of Department 2 – University B	H.O.D 2 – University B
Head of Department 3 – University C	H.O.D 3 – University C

Therefore, this section delineates the study's findings that promote transformative pedagogy in mathematics education, highlighting the necessity of confronting Eurocentric biases and cultivating culturally relevant participation among students. The findings are categorised into three primary themes:

- identification of Eurocentric biases in contemporary mathematics curricula,
- student engagement and empowerment via culturally relevant pedagogy, and
- the influence of transformative pedagogy on student learning outcomes and attitudes towards mathematics.

4.1 Identification of Eurocentric biases in current mathematics curricula

To identify the Eurocentric biases in mathematics curricula, participants were asked, "What are the Eurocentric biases that diminish non-Western contributions and viewpoints in the mathematics

curricula?" Research findings revealed that the major identified biases were the historical exclusion of non-Western contributions and the significant disconnection between mathematical concepts.

4.1.1 Historical exclusion of Non-Western contributions

The historical exclusion of non-Western contributions in the mathematics curriculum has perpetuated bias and limited the representation of diverse perspectives. To address this, it is essential to understand how this exclusion manifests in the curriculum. Consequently, participants stated:

> *The historical omission of non-Western contributions in mathematics education is not simply an oversight; it signifies a systematic bias that influences our comprehension of the development of mathematical ideas. Consequently, by marginalising the rich traditions of mathematical knowledge from other cultures, we deprive learners of a comprehensive understanding of the subject. The incorporation of these contributions is not merely aimed at enhancing representation; it seeks to deepen our comprehension of mathematics as a global language that transcends boundaries. Recognising the brilliance of mathematicians from non-Western cultures empowers all learners, building a narrative in which they perceive themselves as important components of this ongoing story* (ML 2 – University C).
>
> *The pervasive exclusion of non-Western mathematical contributions from the curriculum sustains a Eurocentric narrative that conceals the complex and interconnected nature of mathematical knowledge. This exclusion obscures the profound mathematical traditions established by non-Western civilisations, like the Indian numeral systems, Chinese algebra, and Islamic geometry, which have fundamentally influenced modern mathematics. Consequently, by depicting mathematics as an exclusively Western pursuit, the curriculum supports a spurious hierarchy of knowledge that marginalises non-European viewpoints and perpetuates skewed perceptions of mathematical superiority. This absence not only diminishes the intellectual contributions of non-Western experts but also constrains the mathematical perspectives of students, depriving them of a thorough appreciation of the topic and its worldwide relevance* (H.O.D. 2 – University B).
>
> *...I think the lack of non-Western voices added to the Eurocentric biases that make non-Western contributions and points of view less important in math curriculums. This lack of participation reinforces the idea that mathematics is a field that doesn't need any variety. This makes us learners, especially those from underrepresented groups, less likely to pursue the subject, and it adds to the myth that mathematics is only for a select few* (ML 1 – University A).
>
> *During the classroom observation, the researcher noted that the professors predominantly emphasised the accomplishments of Western mathematicians, including Pythagoras, Euclid, and Newton. Consequently, there was no reference to notable non-Western contributions to mathematics, such as the advancement of algebra in the Middle East or the utilisation of zero in ancient India. Likewise, the educators employed terminology that perpetuated the notion of Western superiority in mathematics. For instance, they characterised non-Western mathematics as "primitive" or "unsophisticated." This language undermined the contributions of non-Western mathematicians and established Western mathematics as the sole valid and advanced form of the discipline. Furthermore, it was then observed that the majority of learners in class appeared to be disengaged when teachers discussed Western mathematics. However, when prompted to share their knowledge of non-Western contributions to mathematics, they exhibited enthusiasm and shared valuable insights* (Excerpt from researchers' observation notes).

The Higher Education Qualifications Framework (HEQF) (2008) has historically overlooked the contributions of non-Western mathematicians, leading to a Eurocentric bias that sustains systemic educational inequality. Furthermore, it has been observed that the framework inadequately reflects the diverse cultural backgrounds of students in the classroom. An analysis of the module guide,

lesson plans, and student work samples revealed that these documents primarily emphasise the achievements of European mathematicians while neglecting substantial breakthroughs made by mathematicians from various cultural backgrounds. This exclusion limits the understanding of mathematical history and reinforces the perception that mathematics is primarily a Western discipline. Addressing this marginalisation is essential for fostering a more inclusive and diverse educational system.

4.1.2 Cultural disconnection in mathematical applications

Similarly, a participant who believed that the cultural disconnection in the application of mathematics reinforces a narrow view of the subject added that:

> *The lack of different cultural viewpoints in math education reinforces a Eurocentric bias that pushes non-Western mathematical practices to the side. This disconnect between cultural events and how math is used reinforces the idea that math is a purely Western field, devoid of the valuable contributions made by other cultures. So, when we don't look at how mathematical ideas came to be in different cultures, we keep up the idea that mathematics is an objective and universal truth, rather than something that was created by people using their creativity and the cultures in which they lived. This disconnect makes it harder for math to help all kinds of students feel welcome and give them power because it hides the many ways that math can be used to fix problems in the real world and talk about personal experiences* (ML 2 – University B).
>
> *Culture-based differences in how math is used reinforce Eurocentric views in our schools, making it seem like Western math is the only correct way to do things. This narrow view overshadows the many different ways of knowing about math that have grown up in different countries over time. If we don't teach these native and non-Western ways of doing math, we keep students from fully learning the subject and limit their ability to think critically and solve problems. We need to fight this cultural dominance and include different mathematical points of view in our lessons if we want to truly be inclusive and give all of our learners' power. Only then can we create a truly inclusive and equitable mathematics education for all* (H.O.D.1 – University A).
>
> *Math has always been presented to me as a universal language devoid of cultural biases. However, my own struggles as a non-European learner have opened my eyes to the pervasive Eurocentricity in its teaching and application. By prioritising European perspectives and methodologies, the curriculum alienates students from diverse backgrounds, creating a disconnect that undermines their potential. This cultural disconnection perpetuates a deficit narrative, reinforcing the false notion that mathematics is an inherently Western endeavour. It perpetuates a sense of inferiority and perpetuates the myth of European mathematical superiority. By not acknowledging the contributions of non-European cultures to mathematics, we marginalise their voices and limit our collective understanding of the subject. A truly inclusive mathematics education must embrace cultural diversity, not only in representation but also in content and pedagogy. Only then can we create an equitable learning space where all students feel valued and empowered to engage with mathematics* (MST 9 – University C).
>
> *During the formal observation, the researcher noted that mathematical examples and word problems hardly related to students' everyday experiences or cultural backgrounds. Consequently, students from underrepresented cultures perceived their viewpoints and contributions as marginalised. It was similarly noted that mathematical principles were portrayed as universal and absolute, disregarding cultural differences in mathematical reasoning. Consequently, non-Western mathematical techniques and beliefs were neither addressed nor esteemed. Moreover, the majority of the observed teaching and learning sessions showed a preference for a Eurocentric application of mathematics, as the mathematical*

> *problems predominantly used Eurocentric ideas, including the Gregorian calendar, European currencies, and Western measurements. This emphasis underscored the notion that Western mathematics is preeminent and exclusively relevant to specific cultures* (Excerpt from researchers' observation notes).

The Higher Education Qualification Framework (HEQF) is crucial in defining mathematical courses in South African higher education institutions. However, there is growing apprehension that the HEQF sustains Eurocentric biases by prioritising Western mathematical traditions, resulting in a cultural disjunction in the application of mathematics. The investigation indicated that the HEQF frequently favours Western mathematical knowledge and procedures, overlooking non-Western viewpoints. This fosters a limited perspective on mathematics, sidelining indigenous mathematical traditions and epistemologies. An in-depth examination of the module guide, class plans, and examples of student work uncovered a notable disparity between the mathematical principles presented and the students' cultural backgrounds. Consequently, numerous mathematical problems in textbooks are perceived as abstract and lacking real-world applicability, especially for students from underrepresented areas.

4.2 Student engagement and empowerment through culturally relevant pedagogy

To address the Eurocentric biases in mathematics curricula, participants were asked, "What culturally relevant pedagogy can be implemented in mathematics classrooms to promote student engagement and empowerment?" Research findings revealed that educators could enhance students' connection to mathematical concepts by developing culturally relevant contexts for problem-solving and fostering empowerment through self-representation.

4.2.1 Culturally relevant contexts in problem solving

Research findings revealed that incorporating a culturally relevant context in problem-solving can foster a mathematics classroom that values diversity, history, and individual experiences, thereby leading to a more inclusive and enriching learning environment. For instance, the following participants stated that:

> *One of the ways by which we can challenge this Eurocentric bias in the mathematics curricula is by creating a relevant context for problem-solving, which allows students to connect mathematics to their own experiences and perspectives, fostering meaningful engagement and empowering them as learners. I believe that when a student starts seeing their own culture and experience reflected in mathematics, it will spark their curiosity and interest, leading to deeper understanding and a sense of belonging* (ML 2 – University A).

> *Mathematics has often seemed so Eurocentric to me, focusing on Pythagoras and other Western figures. The very first time we learned about mathematicians from diverse backgrounds, it opened my eyes to the wider world of knowledge, and I felt more included. Most especially in classrooms, where my culture is acknowledged and valued, I feel like I belong. I am so motivated and encouraged to participate more, knowing that my views and experiences are part of the conversations* (MST 3 – University B).

> *To truly engage our students, we must root mathematical concepts in contexts that reflect their lived experiences. When we relate mathematics problems to their cultures, we not only make learning relevant but also empower students to see themselves as capable mathematicians in their own rights. Also, I believe that mathematics is a universal language, but too often, the curriculum speaks with a Eurocentric accent. Thus, by incorporating diverse cultural perspectives and historical contexts into our lessons, we can challenge these biases and celebrate the rich contributions of all cultures to the field of mathematics education* (H.O.D 3 – University C).

> *The formal observation indicated that including culturally relevant contexts in mathematics problem-solving enhanced student engagement and empowerment while confronting Eurocentric biases in the mathematics curriculum. The observation revealed a bright classroom adorned with maps, artwork, and posters highlighting contributions from other cultures to mathematics and science. Students were arranged in groups to promote collaboration and discourse. The educator presents a problem-solving exercise centred on "Budgeting for a Cultural Event." The objective is to involve pupils in mathematical principles (addition, subtraction, percentages) within contexts pertinent to their cultural experiences and celebrations. The educator supplied materials featuring budgeting examples from diverse cultures (e.g., community potlucks and cultural events) and taught ideas such as equitable distribution and collective accountability, which are frequently highlighted in communal societies. During the problem-solving session, students were urged to employ diverse strategies for resolving addition and percentage issues. The educator underscored the existence of several methods to achieve a solution, acknowledging and affirming the diverse approaches students may present based on their backgrounds. The instructor explicitly addressed the historical contributions of non-European mathematicians and those from diverse cultures during the class. This encompassed allusions to Indigenous mathematical concepts and methodologies, which contributed to contesting Eurocentric narratives in traditional curricula. Nevertheless, the researcher noted that certain students initially encountered difficulties with the mathematical concepts introduced within the context and needed supplementary assistance to connect mathematical comprehension with the cultural framework. Likewise, several students indicated unease over the discussion of their cultural backgrounds* (Excerpt from researchers' observation notes).

The Constitution of the Republic of South Africa (1996) underscores equality, human dignity, and the right to education. It advocates for ideals of inclusion and respect for diverse cultures, which can guide educational methods in institutions. Similarly, the Higher Education Act (No. 101 of 1997) establishes a framework for the higher education system in South Africa, encouraging institutions to develop curricula that reflect the nation's various cultural contexts. The South African Qualifications Authority (SAQA) promotes the creation of qualifications relevant to the South African environment, endorsing the incorporation of local cultures and issues within educational curricula. Together, these documents advocate for higher education institutions to integrate culturally relevant content into their curricula and pedagogical approaches, fostering an educational system that reflects and addresses South Africa's rich cultural landscape.

4.2.2 Empowerment through self-representation

Research findings revealed that the incorporation of student voices and experiences into the curriculum played a crucial role in fostering empowerment. Consequently, students were encouraged to share their mathematical experiences and cultural practices, which were subsequently integrated into lessons. This approach not only validated their identities but also demonstrated the relevance of mathematics in their everyday lives. For instance, the following participants stated that:

> *By integrating culturally relevant examples and problem-solving scenarios into our mathematics curriculum, we allow students to see themselves in the content. Thus, empowerment begins when the student recognises that mathematics is not merely a Eurocentric construct but a universal language that can express their own cultural narratives. Therefore, when students engage with mathematics through the lens of their identities and experiences, they are more likely to be invested in the subject. So, therefore, we need to empower students by encouraging self-representation, validating their perspectives, and showcasing mathematicians from diverse backgrounds* (ML 2 – University C).

> *To truly empower our students, we must integrate their cultural identities into the mathematics curriculum. By valuing diverse mathematical contributions, we not only engage*

> *students but also dismantle the Eurocentric narratives that have dominated our field. I believe that when students encounter mathematics through real situations relevant to their communities, it becomes a powerful tool for empowerment. This approach not only makes learning more engaging but also illustrates how mathematical concepts are used to address social issues, fostering a sense of agency* (H.O.D. 2 – University B).
>
> *Every student has a unique way of thinking about mathematics. so, if our teacher encourages us to share our methods and respect different strategies, it makes us feel valued and engaged – it shows that mathematics isn't just one way. Also, if we had a say in what we learn – like suggesting topics that relate to our lives or histories – it would really change how engaged we feel. So, it is important for us to see ourselves in mathematics, not just famous mathematicians from Europe* (MST 5 – University A).
>
> *Formal observation indicated a variety of depictions on walls, with posters showcasing mathematicians from diverse cultures, including those from Africa, Asia, Indigenous communities, and Latin America. This visual representation challenged the Eurocentric emphasis frequently found in conventional courses. Likewise, the educator employed examples from several cultures while teaching mathematical concepts. During geometry lessons, the teacher incorporated discussions on Islamic geometric patterns and their mathematical significance. Students were encouraged to collaborate on addressing issues relevant to real-world situations within their communities. Examples included financial planning for community events and the examination of local demographics. This relevance fostered increased enthusiasm and ownership of the content.*

The above findings emphasise the importance of integrating culturally relevant examples and diverse mathematical contributions into the mathematics curriculum to engage and empower students. They highlight the need for students to see themselves in mathematics, moving away from the traditional Eurocentric focus to include mathematicians from various cultures, such as those from Africa, Asia, Indigenous communities, and Latin America. By incorporating real-world problems relevant to students' communities and encouraging them to share their unique perspectives and strategies, educators can foster a sense of agency and ownership over their learning. This approach not only makes mathematics more relatable and engaging but also validates students' identities and experiences, ultimately leading to a more inclusive and empowering educational environment.

4.3 Impact of culturally relevant pedagogy on student learning outcomes and attitudes

To examine the impact of transformative pedagogy in mathematics education, participants were asked, "How does culturally relevant pedagogy impact student learning and attitudes towards mathematics?" Research findings revealed that culturally relevant pedagogy can enhance students' academic performance, foster positive shifts in attitudes towards mathematics, and increase student agency and confidence.

4.3.1 Improvement in academic performance

Culturally relevant pedagogy transforms education into a tool for students' personal and intellectual development. By acknowledging the cultural capital of each student, educators can create meaningful learning experiences that reflect students' lives, thereby enhancing motivation, engagement, and, ultimately, academic achievement. For instance, the following participants stated that:

> *……effective instruction must acknowledge the backgrounds and experiences that students contribute to the classroom. When educators utilise culturally relevant practices, they cultivate an inclusive environment that recognises students' identities, leading to enhanced engagement and greater academic outcomes. Thus, this method fosters both knowledge and critical thinking, as well as resilience. Similarly, culturally responsive teaching enables students to relate their*

> *education to their cultural backgrounds. By integrating many viewpoints and experiences, educators can cultivate a learning environment that recognises and affirms the identities of all students, resulting in enhanced academic performance and a more profound comprehension of the subject matter* (ML 1 – University C).
>
> *Culturally relevant pedagogy has converted our classroom into a nurturing community where all individuals feel esteemed. When our mathematics instructor recognised our varied experiences, it fostered an environment conducive to sharing our opinions. This teamwork enabled me to surmount hurdles and enhanced my confidence, which was shown in my grades. Consequently, studying mathematics through culturally pertinent examples enabled me to recognise the subject in my daily experiences. We analysed statistics utilising data from our communities, rendering the material both comprehensible and pertinent. I began to thrive as I was able to connect mathematical concepts to real-world scenarios I encountered* (MST 10 – University B).
>
> *Utilising culturally appropriate pedagogical approaches fosters a learning atmosphere that appreciates students' origins and experiences. This relational approach fosters trust and respect, resulting in increased engagement and significant enhancements in students' academic performance in mathematics. Culturally relevant pedagogy incorporates diverse perspectives into mathematics education, enabling students to tackle problems from distinct viewpoints. This inclusivity enhances classroom discussions and promotes a better comprehension of mathematical subjects, substantially improving overall achievement* (H.O.D 1 – University A).
>
> *Culturally relevant schooling enabled me to perceive mathematics not merely as a collection of abstract notions but as a discipline that embodies my identity. Engaging in projects that showcased mathematical contributions from my culture motivated and empowered me. Consequently, my skills improved, and I started to envision myself as a prospective mathematician. Incorporating cultural themes into our mathematics instruction enlivened the topics. When our instructor integrated algebra with music and art from our backgrounds, I became more involved and was able to comprehend challenging concepts more swiftly. It is beyond mere mathematics; it embodies an integral aspect of my culture* (MST 2 – University A).

The findings demonstrate the impact of culturally relevant pedagogy on students' academic performance, particularly in the domain of mathematics. They underscore the significance of recognising and integrating students' cultural backgrounds into the educational process. By adopting such an approach, educators cultivate an inclusive environment that enhances motivation, engagement, and, ultimately, academic achievement. The findings also illustrate instances of students who excelled when mathematics was contextualised within their cultural experiences, such as analysing community statistics and incorporating cultural themes into the curriculum. This methodology promotes critical thinking, resilience, and a sense of identity among students, thereby transforming their perception of mathematics from abstract concepts to relatable and meaningful content. Overall, culturally relevant pedagogy is posited as a potent instrument for enhancing educational outcomes and fostering a supportive learning community.

4.3.2 Positive shifts in attitudes towards mathematics

Integrating culturally relevant contexts into mathematics education transforms learners from passive recipients into active participants. By connecting mathematical concepts to students' lived experiences, we cultivate a classroom environment where learning is meaningful, leading to increased confidence and enthusiasm for mathematics. For instance, the following participants stated that:

> *Culturally relevant pedagogy bridges the gap between students' home cultures and the school environment, making mathematics relatable. This connection not only enhances understanding but also encourages students to view mathematics as a viable and exciting avenue for future success, fostering a more positive disposition towards the discipline. Thus, by weaving students' cultural narratives and experiences into mathematical instruction, we create an inclusive educational space where every student feels valued. This reinforces the idea that mathematics is universal and accessible, leading to a remarkable increase in student motivation and a lasting positive shift in their attitudes toward learning mathematics* (ML 2 – University C).

> *Through using culturally relevant teaching methods, we have seen a huge change in how our kids feel about math. We gave our kids the tools to see math not just as a bunch of numbers, but as something that can help them understand and get around in the world by making connections between math ideas and their own cultural experiences. This sense of connection sparks their interest and makes them want to learn more about math. I can say that culturally relevant pedagogy has changed how our kids see their part in math because of this. We give them a sense of control by pushing them to share cultural stories and experiences in the classroom. Students no longer think of math as something far away or unimportant. Instead, they see themselves as involved participants in their own learning, which has made all student groups more motivated and successful* (H.O.D 3 – University C).

> *Culturally relevant pedagogy does more than just teach math; it also inspires a new breed of mathematicians who see a place for themselves in this field. We help students imagine worlds where they can do well in STEM fields by showing them how math is connected to their communities and cultures. This change in viewpoint not only makes them like math more but also opens up more job opportunities and career paths for them* (ML 1 – University B).

> *Before, I always thought math was just numbers on a page with no connection to my life. But when we started using culturally relevant examples - like budgeting for a family or analysing sports statistics from my favourite teams - I realised math is everywhere. This connection has made me excited to learn; it feels more like a tool I can actually use in my life* (MST 3 – University A).

The above findings demonstrate how culturally relevant pedagogy can transform the way mathematics is taught. By incorporating students' cultural stories and experiences into lessons, teachers create a more welcoming classroom environment that encourages participation and motivation. Students begin to perceive mathematics not solely as a collection of abstract concepts, but also as tools they can apply in real life, which enhances their interest in and understanding of the subject. This approach not only transforms attitudes towards mathematics but also generates new job opportunities in STEM fields. Emphasising personal connections to mathematics helps students feel valued and engaged in their learning, ultimately boosting confidence and success across all student groups.

4.3.3 Increased Student Agency and Confidence

Integrating diverse perspectives within mathematics education encourages students to take ownership of their learning. When students recognise that their cultural backgrounds offer valuable insights into problem-solving, they are more inclined to participate actively, resulting in a greater sense of agency and self-assurance in their mathematical abilities. For instance, the following participants stated that:

> *Incorporating culturally responsive teaching strategies in my math classroom has transformed the dynamics of learning. By validating students' backgrounds and incorporating them into mathematical discussions, I've witnessed first-hand how their confidence blossoms, allowing them to approach complex problems with the belief that they can succeed. Culturally relevant*

> *pedagogy not only bridges the gap between students' identities and mathematics but also cultivates an environment of trust and respect. This inclusivity leads to increased student agency, where learners are encouraged to voice their thoughts and strategies, ultimately boosting their confidence to tackle challenging mathematical concepts.* (ML 1 – University C)
>
> *By integrating culturally relevant pedagogy into mathematics instruction, we not only create a more inclusive classroom environment but also cultivate a sense of belonging and agency among students. When learners can connect mathematical concepts to their own cultures and experiences, their confidence soars, leading to greater enthusiasm in sharing their ideas and collaborating with peers. Culturally relevant pedagogy shifts the power dynamics in the classroom, transforming students from passive recipients of knowledge into active co-constructors of learning. In mathematics, this means that students draw on their cultural experiences to solve problems, which not only boosts their confidence but also validates their intelligence and intuition* (H.O.D. 2 – University B)
>
> *Since my teacher started incorporating examples from our cultural background in math classes, I've felt more connected to the material. It's not just abstract numbers anymore; it's about real issues we care about in our community. This has boosted my confidence to speak up in class and share my ideas, knowing that they are valued and relevant.* (MST 1 – University C)
>
> *Learning math through culturally relevant materials has changed everything for me. When lessons are connected to my culture and history, I don't just see math as something I have to do; I see it as a tool that helps me understand my story and my future. It has pushed me to take the lead in group work and present my ideas, which I never would have done before*. (MST 8 – University B)

The results demonstrated the significant influence of integrating culturally relevant pedagogy into mathematics instruction. Students articulate that linking mathematical concepts to their cultural origins improves their engagement and comprehension of the subject. This approach transforms the classroom dynamic from passive learning to active involvement, enhancing student autonomy and self-confidence. By acknowledging students' cultural backgrounds and incorporating them into mathematical discourse, educators foster an inclusive environment that empowers students to take responsibility for their learning. The primary theme underscores that culturally responsive teaching not only enhances students' mathematical proficiency but also fosters their self-esteem and collaborative skills**.**

5. Discussion of Findings

Research findings revealed that the participating teacher education programmes in South Africa have historically overlooked the contributions of non-Western mathematicians, leading to a Eurocentric bias that sustains systemic educational inequality. This bias is evident in the analysis of the Higher Education Qualification Framework and module guides employed by these programmes, which primarily emphasise the achievements of European mathematicians while neglecting substantial breakthroughs made by mathematicians from various cultural backgrounds. Consequently, the historical evolution of algebra has often been credited exclusively to individuals like Al-Khwarizmi, overlooking the extensive mathematical traditions present in Africa, Asia, and indigenous cultures (Elamin, 2024; Kathuria, 2024). This exclusion perpetuates a limited understanding of mathematical history and reinforces the belief that mathematics is predominantly a discipline grounded in Western philosophy. Such bias is reflected in the terminology used by lecturers, which frequently portrays non-Western mathematics as 'primitive' or 'unsophisticated.' This framing not only undermines the rich history of mathematics across various cultures but also fosters a sense of alienation among students who may not see their cultural backgrounds represented in the curriculum (Bishop, 1988; Aikenhead, 2017). Therefore, addressing the historical marginalisation of non-Western contributions

in the mathematics curriculum is crucial for promoting a more egalitarian, inclusive, and intellectually diverse educational system (Kathuria, 2024). Furthermore, findings indicate that these teacher education programmes favour Western mathematical knowledge and procedures over non-Western perspectives. For instance, word problems in study materials often present culturally alien scenarios, such as shopping in Western-style supermarkets or measuring distances in metropolitan settings that do not correspond to student teachers' lived experiences. As a result, the absence of cultural relevance frequently leads to disengagement and a sense of alienation from the content, fostering a limited perspective on mathematics that sidelines indigenous mathematical traditions and epistemologies. Hence, Ernest (2024) emphasises the importance of integrating culturally relevant pedagogy and suggests that educators should incorporate real-world applications and culturally responsive examples that resonate with students' lived experiences. This approach enhances engagement and empowers students to see mathematics as a dynamic field that intersects with their cultural identities (Ernest, 2010; 2024).

Similarly, research findings revealed that enhancing students' connection to mathematical concepts by developing culturally relevant contexts for problem-solving and fostering empowerment through self-representation are effective ways for teacher education programmes to integrate culturally relevant pedagogy and challenge Eurocentric biases. As such, student teachers were encouraged to share their mathematical experiences and cultural practices, which were then integrated into lessons. This approach not only validated their identities but also demonstrated the relevance of mathematics in their everyday lives (Grossberg, 1996; Moss & Faux, 2006). Thus, authors such as Bishop (1988), Gay (2015), Olawale et al. (2021), and Ladson-Billings (2023) affirm that educators should foster a more relevant and significant learning environment by linking mathematical concepts to students' cultural experiences. This approach promotes collaboration and dialogue among students while motivating them to take responsibility for their education (Ladson-Billings, 1995; 2001; Kumar, 2018). Furthermore, findings revealed that fostering a mathematics classroom that values diversity, history, and individual experiences leads to a more inclusive and enriching learning environment. This finding resonates with the assertion made by the Constitution of the Republic of South Africa (1996), which advocates for ideals of inclusion and respect for diverse cultures in guiding educational methods in South African higher education institutions. Similarly, the Higher Education Act (No. 101 of 1997) establishes a framework for the higher education system in South Africa, encouraging institutions to develop curricula that reflect the nation's various cultural contexts. In addition, the South African Qualifications Authority [SAQA] (2008) promotes the creation of qualifications relevant to the South African environment, endorsing the incorporation of local cultures and issues within educational curricula (SAQA, 2008). Together, these documents advocate for higher education institutions to integrate culturally relevant content into their curricula and pedagogical approaches, fostering an educational system that reflects and addresses South Africa's rich cultural landscape.

Lastly, research findings reveal that culturally relevant pedagogy can enhance students' academic performance, foster positive shifts in attitudes towards mathematics, and increase student agency and confidence. The findings also provide examples of students who thrived when mathematics was connected to their cultural experiences, such as analysing community statistics and incorporating cultural themes into lessons. Hence, authors such as Bishop (1988), Gutstein (2007), Olawale (2022), and Giroux (2024) assert that when students interact with mathematics in ways relevant to their lives, they cultivate greater confidence and agency, thereby altering their perceptions of the subject. Furthermore, Ladson-Billings (2021, 2023) submits that the impact of transformative pedagogy on student learning outcomes is manifested in the favourable changes noted in academic performance and attitudes towards mathematics. Thus, if effectively integrated, this approach can foster critical thinking, resilience, and a sense of identity among students, transforming their perception of mathematics from abstract concepts to relatable and meaningful content (Gutstein, 2007; Ladson-Billings, 2021). As a result, culturally relevant pedagogy is presented as a powerful tool for improving

educational outcomes and fostering a supportive learning community. This approach transforms the classroom dynamic from passive learning to active involvement, enhancing student autonomy and self-confidence. This shift from passive to active learning is essential for cultivating a sense of belonging and significance in the mathematics classroom, as it not only enhances students' mathematics proficiency but also fosters their self-esteem and collaborative skills (Bishop, 1988; Lubienski, 2000; Gutstein & Peterson, 2005; Ernest, 2010; Bray & Tangney, 2016).

6. Conclusions and Recommendations

The study's results underscore substantial concerns regarding Eurocentric biases in mathematics instruction. The focus on Western mathematicians and the disregard for non-Western contributions sustain a narrative of supremacy that marginalises diverse mathematical viewpoints. This approach not only alienates students from underrepresented backgrounds but also reduces their involvement and interest in mathematics. By neglecting to acknowledge the cultural significance of mathematical concepts and the contributions of diverse cultures, educators jeopardise the creation of an environment in which pupils feel devalued and estranged from the subject matter.

The use of culturally relevant teaching presents a viable solution to these issues. Integrating students' backgrounds and experiences into the curriculum enables educators to cultivate a more inclusive and engaging learning environment. This approach not only deepens students' comprehension of mathematical principles but also allows them to recognise the significance of mathematics in their everyday experiences. The integration of varied mathematical viewpoints can enhance academic performance and foster a deeper understanding of the discipline.

Thus, fostering an equitable mathematics education that respects all students necessitates the incorporation of cultural diversity in both curriculum and teaching methods. Recognising and honouring the achievements of non-Western mathematicians can enrich the educational experience and challenge dominant Eurocentric narratives. Ultimately, creating an inclusive environment where all students feel valued and empowered is essential for developing a profound comprehension of mathematics and its significance from a global perspective.

7. Declarations

Funding: This research did not receive any external funding.

Acknowledgements: The author makes no acknowledgements.

Conflicts of Interest: The author declares no conflict of interest.

Data Availability Statement: The data supporting the findings of this study are available from the corresponding author upon reasonable request. Access will be granted to researchers who meet the criteria for data sharing established by the institutional review board or ethics committee.

References

Aikenhead, G. S. (2017). Enhancing school mathematics culturally: A path of reconciliation. *Canadian Journal of Science, Mathematics and Technology Education, 17*(2), 73–140. https://doi.org/10.1080/14926156.2017.1308043

Alam, A., & Mohanty, A. (2023). Cultural beliefs and equity in educational institutions: Exploring the social and philosophical notions of ability groupings in teaching and learning of mathematics. *International Journal of Adolescence and Youth, 28*(1), 1–24. https://doi.org/10.1080/02673843.2023.2270662

Attard, C., & Holmes, K. (2020). "It gives you that sense of hope": An exploration of technology use to mediate student engagement with mathematics. *Heliyon, 6*(1), 1-21. https://doi.org/10.1016/j.heliyon.2019.e02945

Bishop, A. J. (1988). Mathematics education in its cultural context. *Educational Studies in Mathematics, 19*(2), 179–191. https://doi.org/10.1007/BF00751231

Bray, A., & Tangney, B. (2016). Enhancing student engagement through the affordances of mobile technology: A 21st-century learning perspective on realistic mathematics education. *Mathematics Education Research Journal, 28*(1), 173–197. https://doi.org/10.1007/s13394-015-0158-7

Bullock, E. C. (2024). Racialised deviance as an axiom in the mathematics education equity genre. *Educational Studies in Mathematics, 116*(3), 333–350. https://doi.org/10.1007/s10649-023-10260-x

Christou, P. (2025). Looking beyond numbers in qualitative research: From data saturation to data analysis. *The Qualitative Report, 30*(1), 3088–3100. https://doi.org/10.46743/2160-3715/2025.7560

Clarke, V., Braun, V., & Hayfield, N. (2015). Thematic analysis. In *Qualitative psychology: A practical guide to research methods* (pp. 222–248).

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). Los Angeles: SAGE.

Creswell, J. W., & Poth, C. N. (2016). *Qualitative inquiry and research design: Choosing among five approaches*. New York: Sage Publications.

De Vaus, D., & de Vaus, D. (2013). *Surveys in social research*. Routledge. https://doi.org/10.4324/9780203519196

Elamin, M. O. I. (2024). Muhammad ibn Musa al-Khwarizmi: The pioneer of algorithms and his enduring legacy in artificial intelligence. *Journal of Ecohumanism, 3*(8), 10853–10874. https://doi.org/10.62754/joe.v3i8.5896

Ernest, P. (2010). *The scope and limits of critical mathematics education*. In *Critical mathematics education: Past, present and future* (pp. 65-87). Brill. https://doi.org/10.1163/9789460911644_007

Ernest, P. (2024). The ethics of authority and control in mathematics education: From naked power to hidden ideology. In *Ethics and mathematics education: The good, the bad and the ugly* (pp. 199-249). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-58683-5

Freire, P. (1970). Cultural action and conscientization. *Harvard Educational Review, 40*(3), 452-477. https://doi.org/10.17763/haer.40.3.h76250x720j43175

Freire, P. (1998). *Pedagogy of freedom: Ethics, democracy, and civic courage*. Rowman & Littlefield.

Gay, G. (2015). The what, why, and how of culturally responsive teaching: International mandates, challenges, and opportunities. *Multicultural Education Review, 7*(3), 123-139. https://doi.org/10.1080/2005615X.2015.1072079

Gay, G. (2018). *Culturally responsive teaching: Theory, research, and practice*. Teachers College Press.

Gichuru, M. J. (2017). The interpretive research paradigm: A critical review of its research methodologies. *International Journal of Innovative Research and Advanced Studies (IJIRAS), 4*(2), 1-5.

Giroux, H. A. (2024). *Theory and resistance in education: Towards a pedagogy for the opposition*. Bloomsbury Publishing. https://doi.org/10.5040/9781350458529

Goos, M. (2020). Mathematics classroom assessment. In *Encyclopaedia of mathematics education*. *Springer International* Publishing. https://doi.org/10.1007/978-3-030-15789-0_104

Grossberg, L. (1996). Identity and cultural studies: Is that all there is? *Questions of Cultural Identity, 1*(1), 87-107. https://doi.org/10.4135/9781446221907.n6

Gutstein, E. (2007). "And that's just how it starts": Teaching mathematics and developing student agency. *Teachers College Record, 109*(2), 420-448. https://doi.org/10.1177/016146810710900203

Gutstein, E., & Peterson, B. (2005). *Rethinking mathematics: Teaching social justice by the numbers*. Rethinking Schools.

Gyamera, G. O., & Burke, P. J. (2018). Neoliberalism and curriculum in higher education: A post-colonial analysis. *Teaching in Higher Education, 23*(4), 450-467. https://doi.org/10.1080/13562517.2017.1414782

Jablonka, E. (2014). Critical thinking in mathematics education. In S. Lerman (Ed.), *Encyclopedia of mathematics education* (pp. [page range]). Springer. https://doi.org/10.1007/978-94-007-4978-8_35

Kathuria, A. (2024). Innovative approaches to algebra: Theory and applications across mathematical disciplines. *Arya Bhatta Journal of Mathematics and Informatics, 16*(2), 167–174. https://doi.org/10.5958/2394-9309.2024.00024.0

Kim, K. H. (2005). Learning from each other: Creativity in East Asian and American education. *Creativity Research Journal, 17*(4), 337–347. https://doi.org/10.1207/s15326934crj1704_5

Kohn, A. (2000). *The case against standardised testing: Raising the scores, ruining the schools*. Heinemann.

Kolovou, M. (2023). Embracing culturally relevant education in mathematics and science: A literature review. *The Urban Review, 55*(1), 133–172. https://doi.org/10.1007/s11256-022-00643-4

Kumar, R., Zusho, A., & Bondie, R. (2018). Weaving cultural relevance and achievement motivation into inclusive classroom cultures. *Educational Psychologist, 53*(2), 78–96. https://doi.org/10.1080/00461520.2018.1432361

Ladson-Billings, G. (1995). But that's just good teaching! The case for culturally relevant pedagogy. *Theory into Practice, 34*(3), 159–165. https://doi.org/10.1080/00405849509543675

Ladson-Billings, G. (2021). *Culturally relevant pedagogy: Asking a different question*. New York: Teachers College Press.

Ladson-Billings, G. (2023). Yes, but how do we do it? Practising culturally relevant pedagogy. In J. Landsman & C. W. Lewis (Eds.), *White teachers/diverse classrooms* (pp. 33–46). Routledge. https://doi.org/10.4324/9781003448709-6

Lubienski, S. T. (2000). Problem-solving as a means toward mathematics for all: An exploratory look through a class lens. *Journal for Research in Mathematics Education, 31*(4), 454–482. https://doi.org/10.2307/749653

Maass, K., Geiger, V., Ariza, M. R., & Goos, M. (2019). The role of mathematics in interdisciplinary STEM education. *ZDM, 51*(1), 869–884. https://doi.org/10.1007/s11858-019-01100-5

Martin, D. B. (2010, March). Not-so-strange bedfellows: Racial projects and the mathematics education enterprise. In U. Gellert, E. Jablonka, & C. Morgan (Eds.), *Proceedings of the Mathematics Education and Society 6th International Conference* (pp. 57–79). Freie Universität Berlin.

Mavuso, M. P., Olawale, E., & Mkosi, N. (2021). Integration of indigenous knowledge in the intermediate phase curriculum: A case of South African schools. In Knowledge, Innovation and Enterprise (KIE) Conference (Vol. 1, pp. 7-19).

Moss, K., & Faux, W. V. (2006). The enactment of cultural identity in student conversations on intercultural topics. *The Howard Journal of Communications, 17*(1), 21-37. https://doi.org/10.1080/10646170500487905

Mudaly, V. (2018). Decolonising the mind: Mathematics teachers explore possibilities for indigenising the school curriculum. *Journal of Education*, (74), 67-84. https://doi.org/10.17159/2520-9868/i74a05

Murrell, P. C. Jr. (2017). *Race, culture, and schooling: Identities of achievement in multicultural urban schools*. Oxfordshire, UK: Routledge. https://doi.org/10.4324/9781315089232

Nilimaa, J. (2023). New examination approach for real-world creativity and problem-solving skills in mathematics. *Trends in Higher Education, 2*(3), 477-495. https://doi.org/10.3390/higheredu2030028

Noddings, N., & Brooks, L. (2016). *Teaching controversial issues: The case for critical thinking and moral commitment in the classroom*. New York: Teachers College Press.

Olawale, B. E. (2021). *Democratic citizenship in mathematics teachers' preparation in South African universities* [Unpublished PhD thesis, University of Fort Hare, South Africa].

Olawale, B. E. (2022). Democratic citizenship in mathematics teacher preparation in South African universities: Contradictions in theory and practice. *International Journal of Pedagogy and Teacher Education, 6*(2), 126-139. https://doi.org/10.20961/ijpte.v6i2.61574

Olawale, B. E. (2023). Teacher quality and learner achievement in South African schools. In *Academic Performance: Students, Teachers and Institutions on the Stage* (pp. 1-18). IntechOpen. London, UK.

Olawale, B. E. (2025). Equity and social justice in mathematics teacher preparation: Diving into the nitty-gritty. In B. E. Olawale (Ed.), *Building the foundations: Effective approaches in mathematics teacher preparation* (pp. 1-21). ERRCD Forum. https://doi.org/10.38140/obp3-2025-01

Olawale, B. E., Hendricks, W., & Saddiq, K. (2025). Education for sustainable development and its implication for the preparation of pre-service mathematics teachers. In B. E. Olawale (Ed.), *Building the foundations: Effective approaches in mathematics teacher preparation* (pp. 88-104). ERRCD Forum. https://doi.org/10.38140/obp3-2025-06

Olawale, B. E., Mncube, V. S., & Harber, C. (2021). Critical social pedagogy in mathematics teacher education. *International Journal of Higher Education, 10*(6), 93-104. https://doi.org/10.5430/ijhe.v10n6p93

Olawale, B. E., Mncube, V., & Harber, C. R. (2022). Democratic citizenship education: Towards a model for establishing democratic mathematics teacher education. *South African Journal of Higher Education, 36*(3), 177-193. https://doi.org/10.20853/36-3-4681

Parra, A., & Trinick, T. (2018). Multilingualism in indigenous mathematics education: An epistemic matter. *Mathematics Education Research Journal, 30*(1), 233-253.

Santamaría, L. J., & Jean-Marie, G. (2014). Cross-cultural dimensions of applied, critical, and transformational leadership: Women principals advancing social justice and educational equity. *Cambridge Journal of Education, 44*(3), 333-360. https://doi.org/10.1080/0305764X.2014.904276

Skovsmose, O. (1994). Towards a critical mathematics education. *Educational Studies in Mathematics, 27*(1), 35-57. https://doi.org/10.1007/BF01284527

Skovsmose, O. (2020). *Critical mathematics education*. Cham, Switzerland: Springer International Publishing. https://doi.org/10.1007/978-3-030-15789-0_34

Sleeter, C. E., Neal, L. I., & Kumashiro, K. K. (2014). *Diversifying the teacher workforce*. New York: Routledge. https://doi.org/10.4324/9781315818320

South African Qualifications Authority. (2008). *Regulations for resolving a dispute in terms of the National Qualifications Framework Act, 2008 (GN R743 in GG 33483 of 27 August 2010)*. In *The National Qualifications Framework Act 67 of 2008*. Juta & Company Limited.

Stinson, D. W., Subramanian, J., & Yeh, C. (2024). Strengthening equity and social justice research in mathematics education through critical interrogations of white supremacy and settler colonialism. In M. Clements, B. Kaur, T. Lowrie, V. Mesa, & J. Prytz (Eds.), *Fourth international handbook of mathematics education* (pp. 21). Springer International Handbooks of Education. https://doi.org/10.1007/978-3-031-51474-6_21

Thanh, N. C., & Thanh, T. T. (2015). The interconnection between interpretivist paradigm and qualitative methods in education. *American Journal of Educational Science, 1*(2), 24-27.

Vygotsky, L. S. (1980). *Mind in society: The development of higher psychological processes* (M. Cole, V. John-Steiner, S. Scribner, & E. Souberman, Eds.). Harvard University Press. https://doi.org/10.2307/j.ctvjf9vz4

Warren, C. A. (2018). Empathy, teacher dispositions, and preparation for culturally responsive pedagogy. *Journal of Teacher Education, 69*(2), 169-183. https://doi.org/10.1177/0022487117712487

Webb, N. M., Franke, M. L., Ing, M., Turrou, A. C., Johnson, N. C., & Zimmerman, J. (2019). Teacher practices that promote productive dialogue and learning in mathematics classrooms. *International Journal of Educational Research, 97*, 176-186. https://doi.org/10.1016/j.ijer.2017.07.009

White, A. M., DeCuir-Gunby, J. T., & Kim, S. (2019). A mixed methods exploration of the relationships between the racial identity, science identity, science self-efficacy, and science achievement of African American students at HBCUs. *Contemporary Educational Psychology, 57*, 54–71. https://doi.org/10.1016/j.cedpsych.2018.11.006

Yin, R. (2014). *Case study research: Design and methods* (5th ed.). Sage Publications. https://doi.org/10.4135/9781473915480.n38

Zembylas, M. (2018). Decolonial possibilities in South African higher education: Reconfiguring humanising pedagogies as/with decolonising pedagogies. *South African Journal of Education, 38*(4), 1-11. https://doi.org/10.15700/saje.v38n4a1699