


‘They are just women, what do they know?’: The lived experiences of African women doctoral students in the mathematics discipline in South African universities

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Background: The presence of African women in mathematics has been nearly invisible. The underrepresentation of African women in this field is a result of their historical socio-political marginalisation. The mathematics discipline is politicised, racialised, and gendered to systematically oppress African women. The mathematics fields continue to be a masculine and white male dominated field, which reinforces and preserves masculine culture which is hostile and unwelcoming to women. African women mathematicians are further oppressed because of their racial and gendered identities in fields that are ideologically founded on proving the racial, gendered, social, cultural, and intellectual inferiority of Africans.

Aim: The article aims to exemplify the lived experiences of African women doctoral students in the mathematics disciplines in South African universities. The article critically interrogates the factors that influence the participation, progression, and retention of African female doctoral students in the mathematics disciplines.

Setting: The article comes from a larger study which investigated the reasons why African doctorate students do not become academics after they receive their doctorates in science, technology, engineering and mathematics (STEM) disciplines in South African universities. This paper focuses on the experiences of 10 African female doctoral students at five universities in South Africa. The universities were selected because they ranked in the top five in South Africa. Two of the institutions are historically Black universities and the rest are historically white institutions, with one historically Afrikaner-speaking university—between 2019–2021.

Methods: This article employed a qualitative research methodology, where semi-structures interviews were conducted with 10 African female doctoral participants in mathematics disciplines in five South African universities and is underpinned by the theory of intersectionality.

Results: The findings reveal how interlocking systems of oppression continue to influence the recruitment, retention, and progression of women in the mathematics discipline, thereby providing insight into the mechanisms that need to be altered and/or put in place to actively recruit African female doctoral students and retain them in academic positions.

Conclusion: The article concludes that despite the mathematics field proclaiming neutrality and objectivity nevertheless, African women still experience racism, sexism, and classism. The experiences of African women in mathematics are vital to understanding the reasons why there is a high attrition rate of African women in the mathematics discipline in academia and why they do not become academics when they could transform this discipline.

Keywords: black women; intersectionality; mathematics; STEM; transformation; Higher Education.

Introduction

Sizathu esenza ngiphuze ukuqala iziqu zami kwi mathematics kunesikhathi engangizimisele ngaso ingoba idepartment of Education yayibamba imiphumela yami yabamba nesi tifiketi sami. Bathi basafuna ukuphenya ukuthi uthisha wami akazange yini anginike izimpendulo ngoba wayengakaze abekhona umuntu owake waphasa u matric higher grade kwi mathematics ngo A. Ngiyacabanga ukuthi babengangithembi ingane ehluphekayo ephuma ehig school yase lokishini ukuthi ingathola u A kwi higher grade mathematics. Ngakhoke baqhubeka nophenyo lwabo bamosha unyaka wonke wami.

Note: Throughout this article the terms black and African are used interchangeably and are inclusive of African only not Mixed Race or Indian people.

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Ngaphoxeka ngoba ngangiyithanda imathematics kusukela ngisemncane ngangenza kahle kakhulu.¹

This quote is extracted from Zandile's interview, an African women student in her final year of her doctorate in pure mathematics in a historically black university. Her experience of oppression and exclusion from mathematics began in her secondary schooling, in matric² where she was able to achieve a distinction in mathematics from a black township school, which is severely under-resourced and understaffed and where African students historically have not succeeded or passed their high school sufficiently to enter universities. Zandile, having overcome all the obstacles of being African, coming from a poorer socio-economic background and being a woman, was further victimised by a black administration. This administration oppressed her by withholding her matric results to validate their authenticity, forcing her to defer an entire year of university and to relinquish her scholarship for that year. Such ideologies of mathematics being a white domain and the innateness of mathematical ability being solely for white people or males are internalised by some black people. As a result, they pit members of historically marginalised groups, such as black people especially black women, against each other (Bailey et al. 2011; Battey & Leyva 2016; Thomas, Speight & Witherspoon 2004) and oppress them. Fanon (1968) and Freire (1970) have theorised on the notion of colonised mentality, where the oppressed (African people) aspire to be like their oppressors (white people) by imitating their ideological beliefs and following their racist educational guidelines. These scholars also pondered the question of how to deal with the problem of people who are oppressed, also oppressing their own people. The conundrum of consciousness and reflexivity in which some individuals prevent other individuals from progressing further in educational inquiry is an act of violence, an act of self-violence Freire (1970:157) alludes to. This is what is occurring, where you have an African administration preventing an African child from achieving a university qualification and therefore achieving social upward mobility and consequently breaking the cycle of poverty. This highlighted the Herculean efforts African women in mathematics must exert to overcome the enormous battles of racism, sexism and classism that begin in high school and continue to university where they face the same persecutions from every race and gender as they advance and progress in South African universities. The reason this article begins with a quote in isiZulu is to dispute how mathematics is a field grounded in the English language, percolated in the certainty of its objectivity and confidence in meritocracy to be successful. Conversely, all those ideological

1.The reason why I started my mathematics degree a year later than planned is because the department of education withheld my marks and would not release my matric certificate. They said they had to investigate that my teacher did not give me the answers because no one has ever in [x] high school ever passed matric higher grade mathematics with an A. I think it is because they could not believe me, a poor township girl, from a township high school could get a distinction in higher grade mathematics, so they investigated and wasted a year of my life. I was discouraged because I have loved mathematics from my childhood and have always done well. When I do something good it is unbelievable, yet now I am in my final year of PhD in mathematics.

2.Grade 12 in South Africa is commonly referred to as matric. Short for matriculating your final year in high school.

beliefs are false and rooted in a racial hierarchy amongst people to justify racial and perceived differences, especially around the intellectual and social inferiority of African people. This shaped the constructed and productive knowledge in the mathematics community, institutionalising racism and sexism. The construction of mathematics and race is linked to how academic talent in the mathematics disciplines is grounded in racialised and gendered notions of superiority and inferiority. This article examines what has been occurring in the mathematics discipline in South African universities specifically around transformation. What has been reported as transformation is reform. There are African students who are pursuing doctoral degrees in mathematics, but their presence in these spaces does not mean transformation is happening (Mkhize in press). The South African government has many policies and acts to enact transformation, and there have been campaigns to recruit African students in mathematics. The Department of Higher Education (DHET) and the Department of Science and Innovation (DSI) have agendas such as the 2030 agenda, specifically targeting African girls and increasing their number of participations in the mathematical fields. However, what does that mean when students such as Zandile are high achievers in mathematics but are ostracised and heavily scrutinised for it.

Hussénus (2020) and Leslie et al. (2015) have presented a picture of how ideas, assumptions and stereotypical notions continue to contribute to who is and who is not viewed and recognised as a true member of a science and mathematics community. Studies have been conducted in the Global North, which found that women are underrepresented in mathematics fields, and those practitioners believed that raw, innate talent is the main requirement for success in mathematics, and women are stereotyped as not possessing such talent. Most of those studies are based on white women, and the subjects in question were found in disciplines such as physics, mathematics, engineering and computer science (Leslie et al. 2015). Scholars have documented and critiqued how the mathematics field continues to be a masculine and male-dominated field, which reinforced and preserved masculine culture that is hostile and unwelcoming to women (Jett 2022; Leyva 2017, 2021; Rubel 2016). These studies highlight how African women mathematicians are further oppressed because of their racial and gendered identities in fields that are ideologically founded on proving the racial and gendered social, cultural and intellectual inferiority of Africans. Literature has been conducted on reform in science, technology, engineering and mathematics (STEM) (Gaotlhobogwe 2019; Mlambo 2021) and the transformation of STEM in South Africa (Babalola, Du Plessis & Babalola 2021; Liccardo & Bradbury 2017; Liccardo, Botsis & Dominguez-Whitehead 2015; Idahosa & Mkhize 2021), but research on African women doctorate students in the mathematics field is scarce and that is where the uniqueness of this study lies. In South Africa, the mathematics discipline remains overwhelmingly white and male, yet African people are the majority of the country. Before presenting the findings of this research, it is necessary to anchor the research in the relevant theoretical framework and

to identify gaps in current knowledge. This article begins by reviewing the literature of black women in mathematics, African women in mathematics in institutions of higher education in the South African context and the theoretical framing of intersectionality, followed by the research methods and thereafter the findings, the discussion and conclusion.

Review of literature and intersectionality

This section will be discussing the literature reviewed and the theoretical framing of the article.

Black women in mathematics

Historically, mathematics was considered an elite field, primarily for white men. The reception for women participating in this field has been less than inviting (Borum & Walker 2012:366). The presence of black women mathematicians has been nearly invisible, despite these advances (Albers & Alexanderson 2008; Borum & Walker 2012; Case & Leggett 2005; Murray 2000; Warren 1999). Recent literature shows that women are now the majority when it comes to undergraduate enrolment at colleges and universities in the USA (Borum & Walker 2012). Although females are the predominant population in higher education, they still lag behind males when majoring in certain STEM fields (Freeman 2004). While women earn more bachelor's degrees in science than men (65% and 61%, respectively), their representation in graduate school for STEM fields reflects a gender disparity (Peter & Horn 2005).

Mathematics is historically a white male-dominated field, so the norms or standards originally created centre on the ideologies of that specific group. When women and other minorities enter the field, they have the option of either conforming to the norms or rebelling against them. Therefore, building structures that alleviate the norms of a mathematics culture, which can ultimately hinder the progression of women and minorities, is necessary to increase the participation of these groups in mathematics (Borum & Walker 2012:374). Gender research into elite fields such as mathematics has emphasised the masculinisation of the mathematics field (Leyva 2017). Studies have highlighted how white, masculine, competitive and exclusionary mathematics is to individuals who do not fit those identity categories. Leyva (2021) argued that mathematics education is a white, patriarchal space characterised by ideologies and structures that shape relational experiences of blacks' within-group tensions and resilience. Leyva (2021:117) argues that a black feminist revolution has not arrived in mathematics education, where racial-gendered ideologies thrive and limit opportunities for building intersectional solidarity. Such ideologies of the innateness of mathematical ability being solely for white people or males are internalised, and they pit members of historically marginalised groups, such as black people including black women, against one another (Bailey et al. 2011; Battey & Leyva 2016; Thomas et al. 2004).

Literature has mentioned several reasons that impede the progress of women in mathematics beyond the baccalaureate degree (Leedy, LaLonde & Runk 2003; Powell 1990; Tartre & Fennema 1995). These reasons include a lack of self-efficacy in mathematical abilities that can deter particular groups of students from pursuing the field and an 'internalised' self-perception of incompetence in mathematics and science. In addition, Borum and Walker (2012) argue that negative perceptions and practices of teachers and faculty, discriminatory institutional and departmental structures, and a lack of role models, are all suggested to have an impact on underrepresented groups and their persistence in mathematics (Burrelli 2008; Fennema et al. 1990; Ferguson 2003; Herzog 2004; Nichols & Tanksley 2004).

Battey and Leyva (2016) argue that the only reason certain races do better in mathematics than others is because of the historical and institutional inequities that produced differential opportunities and access, which are tied to racist structures (p. 52). Bonilla-Silva (2003) and Martin (2007) mentioned frames that serve to position black students as deficient and needing to aspire and attain the mathematical standards of white achievement in mathematics. This assumes privilege to white students that they have high abilities in mathematics and are pathologised as a group of high achievers in mathematics. However, international mathematics achievement tests have shown that Asian groups are outperforming white students in mathematics, but white students are not pathologised as 'underperforming underachievers in mathematics' (Martin 2003). Whiteness therefore serves as a means to resist attaching deficient frames to white students (Battey & Leyva 2016).

Borum and Walker (2012) and Leyva (2021:119) argued that black women's isolation in previously white institutions (PWIs) and historically black colleges and universities (HBCUs) reflect white and masculine 'norms' of a mathematics culture, including meritocratic competition and individualism. Such influences limit black women's and girls' opportunities for building solidarity with black peers, even in predominantly black contexts. McGee (2013) wrote: 'Inequities within the educational system have somewhat inhibited [*mathematically high-achieving Black students*] involvement and exposure to building healthy relationships with other Black students' (p. 268). Previous literature (Borum & Walker 2012; Dortch & Patel 2017; Leyva 2021) has largely characterised black women's oppression and resilience in STEM (with the specific focus on mathematics in this article) in terms of group tensions with members of the dominant and more represented groups such as white men and Asian students. Some literature (Leyva 2021) have documented tensions amongst black peers in the mathematical contexts but from an American context. This research is crucial because it highlights the existing tensions that are largely unresearched, and it is necessary to disrupt the black within-group tensions to foster solidarity in unracialised gendered spaces of higher education mathematics within the South African context.

African women in higher education in South Africa

In South Africa, the minority status of African women in higher education is juxtaposed against their numerical majority status in broader society. The positioning of African women in higher education in South Africa as the majority population provides a unique perspective compared to the USA and Europe where African women are minority populations (Mlambo 2017:40). Identifying the reasons African women in an African majority context are absent in academe provides insights into the global and cross-cultural nature of African women's underrepresentation in STEM (Mlambo 2017:40–41). Numerically African women are graduating at a higher rate with the combined black (non-white) rate at 63%, almost double that of white females. Underrepresentation of African women professors, women and African women remains grossly underrepresented in other senior administrative positions, and their standpoints expose them to unique challenges and experiences (Mlambo 2017:42). African students represent the majority (75.6%) of the student population, with African women being the majority. However, academic staff remain predominantly white. African students in this study reported having never been taught by an African female lecturer or professor whilst others said, in their undergraduate or postgraduate studies, they were taught by African lecturers from other African countries and were mostly male.

Mlambo (2017) observed that African professors in South African universities make up 4% of professors and 0.85% represent African women professors. There was a 19.9% increase of African professors in 2017 in South African universities and African women now represent 4.2% of the professoriate in 2020 (Higher Education Data Analyzer 2020). Department of Higher Education (2020) highlighted that black academic staff (African, Mixed Race, Indian or Asian) represent only 39.6% of academic staff at public universities. White people represented the largest population proportion of academic staff at 42.7% (DHET 2020) in a country of almost 60 million where African people are the majority and white people make up less than 9% (Mlambo 2021:158). Africans are overrepresented in support roles where they occupy about 97% of administrative and service positions (Mabokela & Mlambo 2017). Those statistics illustrate how untransformed academia remains and that what is occurring in higher education is reform and not genuine transformation (Mkhize in press).

Racial transformation in higher education

Post-democracy universities in South Africa had three challenges: reproduce and retain the next generation of academics, transform the historical social composition of the academic workforce through equity and redress, specifically for African and female South Africans, and whilst transforming, retain and enhance the academic capabilities of the next generation, through intellectual and academic capabilities related to teaching, learning, research and community

engagement. Some universities enacted transformation charters and made efforts at transformation, but it has resulted in reform. The South African government and universities enacted affirmative action policies to increase the number of African students, especially women in the mathematics disciplines. Affirmative action was in favour of groups marginalized based on historical prejudices, socio-cultural negative attitudes and practices. Mugambwa, Mwebaza and Namubiru (2017) argue that affirmative action was a strategy for closing the gender gap and towards substantive equality. However, statistics show that affirmative action has significantly benefitted white women and not the intended group of African students, specifically African women in South African universities (Borum & Walker 2012; Mugambwa et al. 2017). Badat (2010) mentions that the recruitment and retention of African academics cannot be divorced in some cases from the institutional culture in historically white universities. The experiences of historically white universities as discomforting and disempowering cultural environments that exact a considerable personal, psychological and academic toll. This also influences students specifically in STEM disciplines where African students are expected to handle experiences that they consider unfair in a calm, dispassionate and disconnected way; whiteness is restricting acceptable ways of grappling with the emotions of discrimination and racism (Moore 2008). The persistent assumption is that African appointments, no matter how outstanding their academic records, are 'affirmative action' candidates and are deemed 'unsuitable' despite meeting the necessary criteria (Cornell & Kessi 2017; Kessi & Cornell 2015). Suitability is conflated with 'best' and is often associated with those who historically, academically and culturally belong to the dominant academic social group, which are white people. White men did not believe women could do mathematics, especially not African women, who they deemed inferior racially, culturally and biologically. It is important that factors that contribute to the attrition and success of African women in mathematics must be examined because it would aid in increasing the number of women in this field and retaining them as academics. The real conditions they inhabit need to be investigated to understand what encourages and discourages women from pursuing mathematics. Mathematics is historically a white male-dominated field, so the norms and standards originally cater for that specific group. When women, specifically African women, enter this field they must either conform or rebel.

In post-democracy, South Africa had a 'Good Intentions' transformation, which Msibi (2020) argued focused on the inclusion of African people in white spaces rather than true transformation and change. True transformation (Msibi 2020; Nodoba 2020) argue is transformation of equity, fairness and social cohesion in institutions of violence and exclusion of African people, such as (white universities). White institutions were a project of colonisation, with the sole agenda of dividing and conquering the natives. Universities foster and support white notions of superiority and excellence and association with whiteness to maintain the status quo. The system exists to erase blackness, does not welcome it, or see it, and

consequently Africans must assimilate. The systemic structures and barriers African students face are colonial constructions that persist and show that the white power will not relent and will push back constantly. A particularly insidious form of racism that exists within the universities and STEM discipline is the colour-blind ideology. This ideology perpetuates the idea that it is uncouth to recognise an African person's race, ethnicity or culture. It works with tokenism and the academic rhetoric that is protracted is that resilience is the key to success and career achievement in STEM. This untruth dismisses the invisible forms of racism, such as structural and institutional racism, which are the impenetrable barriers to African students thriving and succeeding in STEM fields (McGee 2021:7). African students in universities and specifically African women in this study reported that they were either encouraged to reconsider perusing STEM disciplines or they were told to be grateful to have been 'allowed' to pursue STEM degrees, they were expected to be quiet, submissive and constantly prove their intellect to show they are worthy to be in these STEM disciplines.

Transformation and African women in higher education

Transformation cannot be understood as a blanket term because it is applied differently to different institutions. Every institution has its own institutional culture and challenges, which require a contextualised approach to change (Ramohai 2019:2). In the South African context, the institutions of higher education have very different transformation needs. Previous white Afrikaans institutions faced challenges relating to racial inequalities than previous black institutions. All higher education institutions in South Africa are subject to rules and regulations, and one of them is to prioritise African women in the transformation initiative (Badat 2010 in Ramohai 2019:6). Attempts of transformation need to redress these imbalances of the past, by understanding the need and experiences of this marginalised group, that is, African women academics. The South African government communicates its mandate to institutions, informing them that African women academics should be prioritised when transforming and diversifying their staff (DHET 2016). Gender needs to be seriously prioritised in higher education institutions, but how do these institutions implement that. Higher education institutions need to respond to gender equity matters, especially pertaining to black women academics. African women still face numerous challenges pertaining to upward mobility, research success and overcoming gender-based epistemological stereotypes (Ramohai 2019:2). Institutional cultures are still predominately masculine, and the staff is still predominately white (Kele & Pietersen 2015; Tsiksata 2007). In the South Africa context, transformation must be used in 'undoing' of the historical injustices that most of the African population suffered in terms of access, availability and representation in the higher education sector. Although redress should include all African people (men too), gender complexities still make African women a priority in transforming higher education institutions (Ramohai 2019:2).

Intersectionality

The analytic approach employed in this study is grounded in the intersectional perspective to examine the experiences of African women doctorate students in mathematics in South African universities. Kimberley Crenshaw (1989) coined the term intersectionality, but it is rooted in Black Feminist Thought. Intersectionality described the way multiple identities based on race, gender, class, ethnicity, nationality and sexuality are systematically and structurally oppressed. These structures systematically oppress African women in ways that do not persecute African men or white women (Idahosa & Mkhize 2021). Tamale (2020) argues that African women experience racism differently from African men, because hers is a 'melded' experience of gendered racism. African women are othered on two fronts (race and gender), while African men are othered on only one (race). Seabrook (2019) argues that intersectionality is a specific feminist theory that interrogated the ways different identities combine to create unique and complex dynamics of oppression and power for individuals and communities as well as the broader social structures that sustain the marginalisation of certain identity positions (Carastathis 2014). These axes of difference go beyond descriptive, but they co-constitute each other (Slater & Liz 2018:341). Cho, Crenshaw and McCall (2013) state what makes an analysis intersectional is an adoption of an 'intersectional' way of thinking about the issues around sameness and difference and their relation to power.

Nash (2008) argues intersectionality focuses on two main areas: the race/gender binary, which argues for an understanding of the multi-dimensions that include ways in which race, gender, class, ethnic identity and context affect experience. Intersectionality reveals the 'racial variations within gender and the gendered variations within race through its attention to subjects whose identities contest race or gender categorisation (Nash 2008:2-3). Intersectionality moves beyond race and gender to consider the ways in which political milieus affect identity and individual experience; for example, colonialism, capitalism and nationalism are incorporated into intersectional analysis (Levine-Rasky 2011). This conceptualisation allowed the researcher to highlight the intersectional 'matrix of domination' and understand the legacy of exclusion in the South African context on multiple subjects and avoid the problem of essentialism and exclusion of particular groups (Nash 2008:8).

Research methods

This article comes from a larger study conducted during the author's sabbatical, which explored the reasons why African women doctoral students in STEM disciplines do not become academics. This study is situated within a critical research paradigm informed by interpretivism and social constructionism because these two perspectives argue that the way in which individuals make sense of the world is subjective and purely derived from their experiences

TABLE 1: Profile of participants.†

| Number | Name | Age (years) | Discipline | Institution |
|--------|----------------|-------------|------------------|-------------|
| 13. | Zandile | 31 | Mathematics (1) | A |
| 14. | Nelisiwe | 32 | Mathematics (2) | A |
| 17. | Londiwe | 30 | Statistics (1) | A |
| 19. | Mbaliyezwe | 29 | Statistics (3) | A |
| 22. | Zakifa'intombi | 35 | Mathematics | A |
| 23. | Vivian | - | Mathematics | A |
| 24. | Monica | 30 | Mathematics (PD) | A |
| 25. | Duduzile | 44 | Bio-Statistics | A |
| 39. | Ntombi'xolo | 32 | Mathematics | X |
| 42. | Zamantshali | 30 | Statistics (1) | X |

Note: All the names are pseudonyms.

†, (Number): Year in PhD.

PD: Post-Doctoral Fellow.

University Codes.

University A: (Historically black).

University X: (Historically white).

(Creswell 2008). The critical research paradigm identifies, contests and helps resolve power imbalances in society that contribute to systemic inequalities and injustice (Taylor & Medina 2013:6). This article employed a qualitative research methodology, where semi-structured interviews were conducted with 73 participants in STEM disciplines in five South African universities. The questions asked the participants to narrate their reasons for pursuing mathematic disciplines in postgraduate studies in universities, their plans after they receive their doctorates in mathematics and whether they are interested in becoming academics in mathematics. The participants were encouraged to narrate their stories and what recommendations they can offer in terms of transforming the mathematics discipline to be more inclusive of women mathematicians. The universities were selected because they ranked in the top five in South Africa. Two of the institutions are historically black universities and the rest are historically white institutions, with one historically Afrikaaner-speaking university. The author interviewed 73 African doctorate women in STEM, but only 10 were in the mathematics discipline and they were used for this article. Because of the Sars-CoV-2 pandemic that prohibited travel and therefore could no longer physically interview the participants, 11 interviews were conducted using online platforms. The author begun by asking the interviewees their demographic information (name, age, highest qualification and organisation affiliation), background information, including place of birth, education and motivations for entering the field, and questions about their experiences as African women in STEM. The participants were guaranteed confidentiality therefore all the names used in this article are pseudonyms. Using a semi-structured questionnaire, the interviews lasted between 40 and 45 min. Interviews were then transcribed and analyzed using thematic analysis. Table 1 summarises the list of the participants.

A thematic analysis of the data was employed using NVivo data analysis software to analyse how participants' social positions intersected with the historical and current political milieu to impact their experiences in the mathematics discipline (Bazeley & Richards 2000). The data were coded for patterns in the intersectional experience of participants to understand the main factors that impacted their inclusion

and exclusion in the mathematics discipline (Saldaña 2009). Participants cited an intersection of institutional, disciplinary, cultural and interpersonal factors as responsible for the decision to remain in mathematics or leave after attaining their doctorate degree. The narratives revealed structural, institutional and disciplinary issues such as socioeconomic status, an intersection of social positions such as race, gender, class and age with historical legacies, departmental politics and the complexities of ethnicity. Cultural issues such as social norms, gendered stereotypes, discrimination and interpersonal issues such as feeling alienated, isolated, excluded and racial-gendered fatigue, which impacted their academic journeys.

Findings and discussion

This section discusses the findings and examines the lingering colonial legacies, ideological and structural discrimination and socio-cultural and interpersonal factors and exposes if transformation is occurring in the mathematics discipline for African women in universities.

Lingering colonial mentalities

Liberating the colonised mind from oppression, as argued by Biko (1978), Fanon (1968), Freire (1970) and Wa Thiong'o (1986), is necessary for Africans to experience true emancipation. This theme has become popular in recent academic debates as we have witnessed the calls to decolonise the academic curricula especially in higher education. However, whilst the call for decolonising the university curricula has gained traction, especially after the student protests of 2015 and 2016 what appears to have gone untheorised, unventilated and unexposed is the insidious nature of how some African academic administrations continue to oppress and prohibit the progress of young African girls, especially in mathematics, as Zandile's narrative at the beginning of the article illustrated.

Zandile's narrative highlighted what many African students especially African girls experience when they are academic high achievers in poor rural or urban areas. Their academic records are overly scrutinised and investigated to confirm that there were no illegal or devious tactics used by the black girl student to have achieved a distinction in mathematics. Two things are being expressed by the black department of education: the first being that they are continuing the colonial and most recent apartheid ideology that African students are academic inferior, and the only way African students could achieve high grades in school is if they cheated. The second point they are reiterating is that African people, specifically African girls, are incapable of being mathematically inclined and certainly not high achievers in mathematics. The fact that they used the argument of 'Zandile's school never had a Black girl achieve a distinction in mathematics, so they must have been something underhanded going on' illustrates the colonial mentality that is deeply entrenched in their psyches. The fact that Zandile's results were an anomaly indicates that this education administration does not believe that an

African child can achieve a distinction in mathematics, especially not a female African child. This is a black administration, which should have celebrated Zandile's phenomenal achievement instead it investigated it. Subsequently, they frustrated Zandile to the point of her considering going into a different STEM field because she realised that her natural ability and mathematical inclination is problematic for administrators. It was serendipitous that Zandile was able to find her way back to mathematics and will now graduate with a doctorate in mathematics. The question becomes how many other African girls have gone through Zandile's experience and have not been fortunate enough to enter university or dropped out because they were forced to enter other fields of study when they wanted to pursue mathematics but were declined because of their intersectional identities of being African, women, poor and from disadvantaged secondary schools.

Londiwe

Londiwe stated:

'When you are a woman people tend to look down on you. As if you don't know what you are talking about. They often don't trust you and you constantly have to keep on proving yourself. People tend to look down on you especially when you seem young, they treat you as if you don't know anything. That what makes you feel isolated ... The only problem starts when you are working with men, they think that they know everything. They act as if they are brilliant but in reality, that is not true.'

Londiwe's narrative emphasised that as a woman, everyone (including other women) always undermine and underestimate them. African women are especially compounded with the additional layer of being raced as well as gendered making their experiences intersectional in nature. African women experience microaggression based on their multiple identities, and then they must co-exist in a mathematical environment whose ideology does not believe women to be capable of producing high-quality mathematics, especially not African women. The participants all reiterated that they were not immediately deemed intellectually capable, and they had to constantly prove their competence. Unlike white male mathematicians who were trusted solely based on their being white and male and in a field in which the dominate nature and culture was designed for them to thrive and succeed in. As mentioned above the knowledge bearers have always been expected to be white men, and when individuals who are the antithesis of those identities enter white hegemonic spaces, they are disruptive, which forces the institutional culture and environment to constantly resist their intrusion. Londiwe offers a further analysis of her experiences within mathematics, in that of being young, African and female in an environment where old white men are dominant norm which is especially tricky landscape to navigate. Ageism is something literature only acknowledges when pertaining to the elderly facing discrimination because of their old age. Age as an additional discriminatory factor has not heavily been researched. Some studies foreground

age, but they all focus on ageism pertaining to the elderly and not the youth. Mkhize (in press) argues that the combination of sexism and ageism forms a new form of marginalisation, which is further intensified by being in a discipline such as mathematics where the other layers of race, gender, class and ethnicity are already deemed unsuitable. Londiwe also mentions the patriarchy that is a consistent factor in mathematics. Men believe they are intellectually superior as well as gender superior to women. African women experience the micro- and macroaggression of the superiority of white men in mathematics, but it is combined with racial-gendered discrimination, which is directly linked to the colonial and apartheid mentality of viewing African women as people only capable of domestic labour and not intellectual acumen. The African men who treat African women the same way, their discrimination is situated by patriarchy and based on gender, and this is further explained in the last theme.

Ideological and structural discrimination

Mathematics is an elite field that requires superior intellect and focused dedication to mastering it. Ideologically mathematics was a discipline only for white men; only exceptional women could participate and certainly not any African or African women. With that historical ideology that persists today, African women face enormous challenges when they enter the mathematical field and their obstacles are ideological, structural as well as socio-cultural, as the narratives will illustrate. This exclusion begins even before African women enter university, because, as Zakifa'intombi expressed, in high school the teachers did not encourage them to do mathematics. Zakifa'intombi's narrative focused on higher grade³ mathematics not mathematics as a whole. Higher grade mathematics is more challenging and offers the students more opportunities, such as being able to pursue a mathematical degree in university as opposed to taking standard grade mathematics. What has been occurring is that high schools have been under increasing pressure from the school boards, school leaders and the department of basic education to increase the number of African students passing mathematics. Therefore, there is strategic exclusion by student numbers occurring in these townships and rural schools to increase the pass rate. Consequently, these schools have an agenda to pass as many students as possible by discouraging students not to take mathematics or to take it on a lower level such as standard grade to increase their chances of passing mathematics. The implications of encouragement, gender, school number of passes are all a result of pressure from the leadership of the school and department of education to meet certain targets and agendas at the expense of African students, specifically African girls wanting to pursuing mathematics.

If students have already subconsciously received these messages of discouragement (from teachers who are also

3. In South Africa certain subjects like mathematics are offered in two levels: higher grade mathematics and standard grade mathematics (mathematics literacy).

African) when they enter universities, this discouragement is compounded by race as well as gender and to some extent even class.

Zandile

Zandile said:

‘Yes, I have there was this undergrad module (Math *) I was employed for to tutor and just because I was a black female after some time, they fired me because the pay for that module was high, and workload was not high. According to them they said that they were only going to hire lecturers to tutor the course. In general, to become a tutor to you must be a postgraduate student, it would be a first for lecturers to be hired as tutors as well. The students even signed a petition to bring me back as their tutor, but the department didn’t care.’

As the narrative emphasised as soon as African women enter certain spaces, their presence forces the structural rules and criteria to change to further exclude them from these occupations. The fact that Zandile was now tutoring and in effect responsible for the grades (and subsequent future) of mathematics students progression (or not) the system shifted and reorganised itself to create a ‘new rule’ where she would no longer be able to be a tutor unless she meets a new criteria they arbitrarily put in place. They replaced Zandile with a white male lecturer. If Zandile was of a better socio-economic class and not a first generation student she may have had access to networks and resources that would have helped her fight her unfair dismissal because of a new arbitrary rule that was implemented when she became a tutor. This illustrates how the ideological (women, especially African women are deemed unsuitable for mathematics), the political (women are intellectually inferior to be in mathematics) and the systematic (women cannot teach mathematics) all work simultaneously to exclude African women from full participation in the mathematics field.

Another participant Nelisiwe highlighted how even though they are all doctorate students in mathematics only certain races and not women are elected to teach mathematics.

Nelisiwe

Nelisiwe said:

‘Everyone knows only the white students and sometimes, although very rare, will be Indian or nonindigenous African students are elected to be tutors and they are all men.’

Institutional spaces constrain or afford differential access to people, resources and work. In distributing this access, institutions legitimise certain ideologies through the physical space, positioning of different groups in terms of power and presentation of history, such as having a young African woman mathematics teach or tutor mathematics. This woman is the opposite of what the institution deems individuals with innate mathematical abilities and those are white, male and old. This African woman mathematician

is disrupting the ideological, structural and historical norm of mathematics education and that is disorientating and results in the system pushing back to ‘remove the disruption’. This once again highlights the mathematical fields’ ideology of only trusting students who they deemed the ‘legitimate’ mathematicians and those are white and males but not African or Indian. As the narratives have all highlighted this systematic and structural exclusion of them as teachers for other mathematics students in fact benefited them as they were able to finish their doctorate degrees on time or early because they were not burdened with teaching or administrative work or tutoring. Unlike their male counterparts who are still pursuing their mathematical doctorates and are progressing slower because of their teaching commitments. It is very interesting that Nelisiwe mentions how nonindigenous African males are considered for teaching and tutoring positions and not indigenous South African students. This points to the perceived xenophobic belief that nonindigenous African students are intellectually superior to the indigenous African students. However, this example attests to the tensions that do exist between indigenous and nonindigenous Africans, especially in STEM higher education (Mkhize in press), but this phenomenon was not the central focus of this current work.

Socio-cultural and interpersonal factors

The stereotypes faced by black women as mentioned earlier have an influence on their experiences and how they are treated in the mathematics disciplines in South African universities.

Monica

As the following narrative of Monica highlights:

‘So, I think the reception wasn’t, it wasn’t too ummm ... because we were ladies. I could remember one of the lectures saying normally if people come for post graduate mathematics, they give them classes to teach but even if it is just for tutorials or something. He was addressing it to the, I think was it the ... one of the, he was suggesting to one of the big guys there, let me put it that way. And the big guy said ... we were there, and he said what can they do, they are females what can they do, can they stand in front of 50 students, a class of 50 students? And the other man was like it’s what we normally do, and he said no no no no, they are females Anyway, it was for the best because it gave us more time and the two of us (two females doing PhD in mathematics) we finished in two years, like no extension nothing. We finished, the people that came after us they had a tough time finishing because they had to teach and tutor.’

This emphasises how the system is vehemently invested in maintaining the status quo of exclusion, especially of African women, that in effect it is allowing African women mathematicians to progress and to finish their doctorates before or on time because they do not have the added responsibilities of administrative work and tutoring other students. The men they deemed legitimate teachers are consequently saddled with teaching and administrative

work that goes with being a tutor and therefore struggle to solely focus on their doctorate work. It is interesting to note that these narratives of structural exclusion are from students who come from historically white universities and historically black universities. African women are either burdened with enormous pressure of having to constantly prove their competency and are given additional work, almost to test their resilience and aptitude, so if they fail, they are fulfilling an already established ideological belief that African women are intellectually inferior and do not belong in mathematical spaces. On the other hand, African women are ignored and excluded, which has both a good and bad outcome. A good consequence is that they cannot be encumbered with additional work and other responsibilities that take them away from their mathematical work; however, the bad outcome is that they do not get any support or mentorship to advance as quickly as the other male and white students.

Participants raised important points about transformation. They argued that if we are promoting transformation then it needs to go beyond just demographic change. Mkhize (in press) argued that what is occurring in mathematics disciplines in South African universities is demographic change and not genuine transformation. Sincere transformation can only occur when certain strategic positions of decision making are inhabited by people who are the demographic majority of the country and not the white minority (Mkhize, in press). Zakifa'intombi also mentioned an important and usually overlooked observation in that the promotions criteria are skewed in favour of the men. African women face gender structural obstacles and systemic cultural biases that are founded on a history of patriarchal family systems. Women have additional responsibilities that society demands of them, such as childcare and children rearing, which takes them away from their research and ability to consistently publish. Men do not have those gendered patriarchal expectations placed on them, so they are able to conduct research and publish more consistently, faster and constantly compared to women.

Discussion and conclusion

A critical area of concern for South Africa has been how to attain gender equality as well as gender parity so women can be equal contributors to the knowledge economy, especially in the science and mathematical fields. African students are extremely underrepresented in the mathematics disciplines and the number is even smaller amongst African women in the field. This miniscule number has consequential implications to their contribution and representation in the mathematics field. As the narratives have indicated, African women in mathematics are systematically excluded from being teachers of mathematics. There are many reasons for this, racism, sexism and classism, but what the mathematics departments do not realise is that by preventing these African women from teaching they are giving them more time to finish their doctorate degrees before or on time and thus become doctorate graduates before their male doctorate student counterparts who are saddled with teaching and

other administrative work. Therefore, their discriminatory practices are advancing the people they aim to disadvantage.

Racialised patriarchy heavily influenced the participants' experiences in that their high school teachers did not actively encourage them to pursue mathematics, and a black administration vigorously tried to prohibit some of them from entering university to continue to study mathematics, because of the ideology that African girls do not belong in mathematics. These narratives expose how despite the call for transformation and the belief that transformation is occurring it is not. Transformation will not be achieved if the mathematics discipline continues to overtly and covertly discriminate and exclude African women mathematicians. Replacing white mathematicians with African ones does not mean progress is being made, because as noted at the beginning of this article it is the black administration and African mathematicians who also oppress and victimise African women. There needs to be a sincere effort to find viable solutions that are premised on achieving racial and gender equality for African women in the mathematics field.

Bathey and Leyva (2016:59) highlight that in the west a racial hierarchy of ability in mathematics exists whereby whites, and Asians at the top, produce real benefits for these groups. Perceptions become real and this directly influences how blacks are treated in mathematics classrooms, the forms of instruction available to them and what courses schools provide, which, in turn, lead to different testing outcomes (gaps). Institutions make these ideologies concrete when they provide blacks impoverished forms of instruction and teachers through tracking and reduced funding. This then serves to legitimise the ideology that blacks are innately worse at mathematics rather than deconstructing the role of institutions or noting the efforts of educators and communities to combat these racist structures daily. This is also true of the South African context whereby there is a national agenda of increasing the number of African students, especially African girls in mathematics, yet the actions of certain black schools are contravening that agenda by actively discouraging African students from pursuing mathematics from high school to university levels. DHET is at the top and other departments, such as Department of Science and Technology and Department of Basic Education, all follow the policies and agendas stipulated by DHET. One could argue that DHET is not transformed, and the question becomes what it means for the national system and all other educational departments that fall under DHET if DHET itself is not transformed. As Zandile's quote at the beginning highlights how she was oppressed as a high achieving African student in mathematics by an African administration in education. Zandile's mathematical results were scrutinised by the Department of Basic Education that falls under and reports directly to DHET. This type of oppression is at worst allowed to occur and at best condoned by DHET to continue scrutinising high marks attained by African students in mathematics from poor urban schools. The implication is that all these departments need to be transformed especially

when knowledge needs to be produced in these mathematical spaces because the colonial mentality and internalised racism that only white people's knowledge is legitimate persists even within African administrations. These departments and institutions are perpetuating a racial and gendered hierarchal belief that only white people have mathematical abilities; this belief may be subconscious, but their actions make it real.

An aspect that is not heavily researched is the emotional labour African students need to navigate when faced with racism and sexism. Even for students achieving mathematical success, the management of hostile environments were emotionally debilitating. Whether it was the effort to prove a stereotype wrong by being high achievers to project conformity, the students experienced emotional distress and exhaustion. Therefore, more racially hostile environments produce more emotional labour from racism (Battey & Leyva 2016). These African students experienced oppression even from African men, hence the title of this paper, *They are women what do they know*, was articulated by an African man in a classroom of African mathematical students. These African women were oppressed because of racialised patriarchy and the white masculinised mathematical environment that privileged whiteness first and maleness second. Being African women, they did not inhabit any of their identities and even their racial commonality with the African men did not protect them from their sexism and belief of their gendered and intellectual inferiority.

In mitigating the negative experiences and struggles of African women in mathematics a lot of measures have been implemented, but most of the policies remain ideological at best. The narratives reveal that while policies put in place have addressed some of the structural and material challenges with including women, challenges remain with ensuring progression and retention. Subtle discursive, institutional and interpersonal practices continue to ensure the exclusion of African women in the mathematics disciplines. This points to the need for policy to integrate and take into consideration material and the discursive issues, in addressing the challenges with inclusion, progression and retention. One way of addressing the discursive aspect is to implement programmes to foster the development of critical consciousness on how assumptions and stereotypes not only deter women from enrolling into mathematics fields but also work to ensure that those who make it into the field do not succeed.

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