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Transgressing for Access: A Call for Higher Education Reform to Support Black Females in STEM

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Abstract: *There continues to be the global demand for a qualified workforce in science, technology, engineering and mathematics (STEM). Yet, for Black females in South Africa this means combating the legacy of Apartheid to overcome challenges due to race and gender. This paper draws data from a qualitative study of four Black South African females in STEM careers. Through their voices they identify ways in which they transgress gender and race to gain access to STEM careers. Further, their families transgress cultural norms in order to offer support for unfamiliar career pathways. Their narratives call for a transformative change in higher education to address the physical and safety needs of Black females in South Africa and the removal of the burden of educational fees for Black families. This is echoed in the 2015 #FEESMUSTFALL movement. Finally, there is a need for the creation of quality higher education institutions near Black townships.*

Keywords: STEM; gender; South Africa; #FeesMustFall; females; race

Introduction

Competitive nations have realized that an educated workforce and citizenry create income and national wealth (Goldin and Katz, 2008). For Post-Apartheid South Africa this presents a challenge in that prior to 1994 under the Apartheid system, citizens of South Africa were educated based upon their racial classification; Europeans were privileged with quality schools and universities, and, at the far end of the spectrum, were Black South Africans who received an inferior Bantu education (Cross, 1992)**.**

Under this Bantu education system Blacks attended schools with inferior buildings or no buildings, lack of resource materials, poorly trained teachers and overcrowding. In 1978 there was one teacher for every 49 Black students, whereas there was one teacher for every 20 White students (Christie, 1985). In contrast, Whites attended schools with adequate facilities, equipment and trained professionals (Christie, 1985). These would be referred to as the Model C schools.

This structure specifically affected Black South African females by limiting them to minimal education and leaving them intellectually unfit for employment, except as domestics, laborers

and child care providers to White families (Jansen, 1990; Mabokela and Mawila, 2004; Prevost, 2017). They could not hold jobs as secretaries or bank tellers in the same way that White females in South Africa were filling these jobs (Msimanga, 2014). This was by design so that the Apartheid regime would have the subordinate work force it needed to continue their political and social structure while limiting competition for White workers (Msimanga, 2014).

Black South African females also faced educational limitations due to patriarchal systems that dictated roles for females. Gender constructs and identity are still driven by parents, siblings, family, friends, schools (through teachers and peers) and the media (Mthethwa-Sommers, 1999; Pheko, 2009).

These constructs dictated and favored the role of wife and mother (Mabokela and Mawila, 2004; Okeke-Ihejirika, 2009). Historically, many Black African families gave preference to the education of the male offspring over their female children (Martineau, 1997). This gendered expectation has left some females unsupported in their desire to acquire higher education.

This article uses the narratives of four Black South African females and their access to science, technology, engineering or mathematics (STEM) careers to underscore the need for higher education reform that specifically addresses the needs of females. What is unique about these females is that because of their age (under 40) they were educated under the Apartheid system (Booysen, 2016). The term *transgressed* is used based upon the work of feminist writer, bell hooks (1994) who called for higher education to transgress, resist and move beyond the normal boundaries in an education system that has silenced and excluded the voices of students of color. This article will demonstrate the ways in which these females transgressed the gendered norms of their society and have overcome racial limitations to participate in STEM careers. They transgressed a Bantu education system that limited the access of Black South Africans to higher education. The question is: How can universities in South Africa better support Black females in their pursuit of higher education and STEM careers?

The article begins with an exploration of gender roles for Black African and specifically South African females. Second, it will examine the Apartheid structure and its effects on Black education. Finally, it will address the STEM pipeline and the need for a diverse STEM workforce.

Background on the Education of Black Females

Gender structures have attempted to limit the roles of Black African females to wives and mothers while at the same time rendering them economically disadvantaged due to a lack of education and job opportunities (Okeke-Ihejirika, 2009). Mthethwa-Sommers (1999) found that Black females in township schools in South Africa were still exposed to a curriculum that fostered expectations of knowledge in cooking and cleaning. Further, these gendered

stereotypes are internalized and Black females self-reported that they did not believe females should be leaders and especially lead groups when men were present (Pheko, 2009).

Msimanga (2013) recounts the instruction received from a male teacher prior to exam time. Speaking to an all-female class he stated:

> You have to work twice as hard because you are girls—if those boys fail, they can go and work in the factories or on the farms, but you can't. You have to work three times harder because you are girls-- you have no inheritance (p, 7).

This is an illustration of the social dilemma of the African females where she is told extra work is needed to prove her academic worth and ability (Snyder, 2014). Education is not needed when the expectation is that you would be married or work as a domestic (Msimanga, 2013).

Black African females who pursue an academic career beyond high school are in a new arena and are opening doors for many (Rawiri, 2014). They are forced to participate in two distinct cultural worlds: the culture of home where being a female often means defined roles and responsibilities in the home. This contrasts the culture of academia where the student/female has responsibilities and gender barriers to overcome in a system that was designed by non-African males (Mabokela and Mawila, 2004). Female students traverse two worlds: home and family which embody the traditional rules and community of practice and the rules and community of practice of the new academic institution (Rawiri, 2014).

Mamphela Ramphele was one of the first Black female doctors that South Africa produced during Apartheid. She defied the prescribed path of teaching or nursing and held firm to becoming a doctor. In her autobiography, Ramphele (2013) states that "It was not the desire to serve which influenced my career choice, but the passion for freedom to be my own mistress in a society in which being black and female defined the boundaries within which you could legitimately operate" (p. 67).

Upon completion of high school from the Dutch Reform School she was told that she was a woman and a poor Black person and could not become a medical doctor. Nonetheless, Ramphele fought to transgress these racialized and gender barriers. These examples narrate the double bind- race and gender- that Black South African females often encounter due to racialized and gendered structures.

Black Female Education and South African Apartheid

The British were the first to establish formal universities in South Africa (Marcum, 1982), which included British and Boer universities (Afrikaans which are of Dutch and German descent). Under the British there were no exclusions to the universities based upon race but few Blacks, Coloureds or Indians were qualified for admission. The education of Blacks was restricted because Afrikaners did not want to compete for jobs and preferred to maintain their superior social position (Jansen, 1990; Mabokea and Mawila, 2004). This form of adaptive

education, similar to the American South, meant that labor requirements prescribed the educational opportunities in order to maintain the subjugation of Black workers (Prevost, 2017). For Black females, these adaptive educational structures meant that Black females were exposed to a curriculum and training that was often limited to agriculture, handcrafts, teacher and healthcare (Prevost, 2017). These structures sought to keep Black females tied to their environment through growing and caring for crops for their family's consumption.

After the election of the National Party, or Apartheid Party in 1948 the Afrikaners took power and decided to leave the British Commonwealth (Jansen, 1990). They quickly moved to establish an Apartheid Education curriculum for all its citizens in order to control the dissemination of knowledge (Jansen, 1990). The deception of this curriculum is that it appeared to offer racial distinctions by promoting ethnic pride and racial identity (Jansen, 1990). However, with the insights learned from their American counterpart of "Separate but Equal", it is evident that this ideology was intended to subjugate non-White South Africans.

The Apartheid educational principles reflected in the Bantu Education Act of 1953 were that Blacks were to serve Whites and were not to be "over educated" because they would not be granted access to all career pathways (Christie, 1985). To foster this structure in education, separate universities were set up based on the races in South African. Established were White-only universities, Black-only universities and Indian-only universities. Black universities were not intended to produce research scholars. Many of the professors who trained students, although White, did not hold a Ph.D. and were not research competent (Snyder, 2014). By the 1980s, all South African universities, regardless of race were staffed by professors who were predominantly White and mostly Afrikaners (Marcum, 1982; Christie, 1985). These racialized structures created additional barriers for Black South African females that would further limit their career choices.

Effects of Economic Differences on Education

Due to the Apartheid legacy, economic access and poverty reflects the former regime structure of power. In 2008 White South African income average was 75,297 Rand per person whereas for Blacks it was 1,790 Rand per person. Blacks in South Africa continue to hold the highest poverty numbers compared to Whites, Coloureds and Indians (Leibbrandt 2010). Economic power affected the way education was funded and therefore accessed (Lemon, 2004). Limited economic power results in limited access to quality schools and universities.

For Black South Africans this means attending state schools that are measured poorer than many African countries (Case, 2013). This lack of equitableness creates a visible effect on the academic outcomes of learners. In the Eastern Cape, the third most populated province, poor schools in the eastern part that are greatly affected by the former Bantu education system, suffer from poor buildings in need for repair (Lemon, 2004). Additionally, as recently as January of 2014, in northeastern Limpopo province, a six-year-old attending his fourth day of school fell into a pit toilet (a toilet that collects human feces in a hole in the ground) and died (Moeti, 2014). While Model C school students attend schools with flush

Beverly A King Miller

toilets, Black township children still attend schools that lack basic services like a toilet, sinks for handwashing and proper kitchen facilities for meal preparation.

Effects of Teacher Quality Differences

Under the Apartheid regime teachers were trained differently based upon race, with White teachers receiving the best training (Cross, Mungadi, Rouhani (2002). Even in post-Apartheid South Africa the structural effects of the regime lingers and is evidenced in the outcomes of schools like those found in the Eastern Cape (Ngoma, Govender and McLennan, 2017). Maphosa, Mutekwe, Machingambi, et al.,(2012) calls for teaching accountability among South African teachers but recognized that this begins with teacher training and continuous professional development. This is needed to counter the disparity of pass rates based upon racialized school structures. In 2014 only 20% of the Eastern Cape high school graduates passed matric testing meeting the university admission for a Bachelor's degree (Pillay, 2017). Matric tests are high school exit exams that determine entrance to university. In 2015, the privileged western side of the Cape boasted a 60% matric pass rate for high school graduates, while the eastern side of the Cape was at a 40% pass rate (ECSECC, 2016). These results are directly tied to teacher quality and training, but limits the access of Black South Africans to higher education.

Teacher quality and training levels the field for all students. In 2009 the matric pass rate for Model C schools in South Africa was 94%, but for Black students specifically it was 88%; the pass rate for Blacks in non-Model C schools was only 55% (Roodt, 2018). This seems to suggest that if Black South African students are given a chance to be in a school with qualified teachers and supplies they are able to adequately perform with their White peers, thus increasing their ability to qualify for higher education.

Effects of Curriculum Change

The White papers called for curriculum reform that reflects democratic principles to alter the present hegemonic structure (DOE, 2000). The adoption of Curriculum 2005 would move the system from content based to outcomes-based instruction. Barriers continue to impede the transformation that promised to amend the inequities in educational resources for non-White students. Curriculum 2005 addressed the needs for mathematics and scientific literacy in South Africa. One critical outcome for the South African student was the "use of science and technology effectively and critically" (Cross, Mungadi and Rouhani, 2002, p.11). Thus, it was the goal of the new government's educational reform to bring about a scientifically and mathematically literate citizen who would be equipped to access STEM careers. This further highlights the disparity in STEM access for Black South Africans due to poor teacher qualifications.

Many rural and former Black township schools are ill equipped to adequately implement the new Curriculum and Assessment Policy Statement (CAPS) for science (Christie, 1985; Singh and Singh, 2012). According to Singh and Singh (2012) many teachers still employed the "chalk and talk" method that is contrary to best practice science methodology. Too often

Black students are subjected to a teaching style that is dependent on lecture and rote teaching and banking education (Freire, 1970).

STEM Spaces: Access to STEM Pipeline

STEM careers rely on skills and training. These may include: scientific literacy and computational abilities. Laugksch and Spargo (1999) found that Black South African males who matriculated from high school showed higher content levels of scientific literacy than Black female South Africans. In general, Black South African students who graduated from high school were found to have lower scientific literacy skills when compared to White and Indian South African students (Laugksch and Spargo, 1999). Again, another outcome of the racialized Apartheid educational system.

South Africa has been ranked second to last in the world for science and math proficiency (Evans, 2013). In 2014 the World Economic Forum (WEF) ranked South Africa last in math and science. (Wilkinson, 2019). This was disputed by the Department of Basic of Education who said that standardized tests were not used for this determination. However, they did agree that there were issues with math literacy for South African learners.

Woessmann (2016) reported from the Trends in International Mathematics and Science Study (TIMSS) 2011 that 8th grade learners in South Africa ranked second to last with a score of 315. This means that South African learners have a 5-6 year achievement gap difference when compared to the top performing nations. Woessman (2016) further analyzes outcomes based on family income, resources and institutional school systems in order to share a comprehensive picture that accounts for socio-economic factors. This would significantly impact South African data that is skewed by an economic structure where Blacks have the highest poverty numbers.

 Letaba (2017) analyzed the TIMSS 2015 report which ranked South African grade 9 students at 38 out of 39 countries with scores of 372 in math and 358 in science. TIMSS score ranking for 2015 considered scores of 400-475 as low, and less than 400 meant that benchmarks were not achieved. The low performance of South African learners for mathematics at grade five and nine (and science at grade nine) is linked to the factors at home, school and community. The findings revealed that learners at independent schools performed the best followed by fee-paying public schools and the worst performance by those from no-fee public schools (Letaba, 2017). This supports the evidence that economic differences among Whites, Blacks, Indians and Coloureds impacts educational access and ability to pursue higher education.

Research Methodology

The females from this qualitative case study were educated under a system that limited access to quality education based on race and gender. These constraints attempted to deny their inclusion in STEM education. However, in each narrative they share ways in which they transgressed systemic constraints in order to enter their STEM career.

Respondents

There were four participants in this purposive sample who were employed in STEM fields. One participant was an engineer working as a building inspector for the city of Johannesburg; the second has Ph.D. in Chemistry and worked at a large University in Johannesburg; two others worked in IT (Information Technology) at a different large University in Johannesburg.

Data Analysis Procedures

Data was triangulated using interviews, observations at their place of employment and field memos and journal (Creswell, 2007; Emerson, Fretz and Shaw, 1995). Each answered 15 questions and clarifying questions in 2-3-hour interview times depending on the participant. All observations were completed over a 4-5-hour time span depending on the employment and privacy issues for each participant. All have been promoted since these interviews.

All participants were interviewed privately, and tape-recorded sessions were transcribed verbatim by the researcher. All participants spoke Standard English, although they also spoke their native tribal language as well. I contacted my participants for member checking and they edited and updated information in order to ensure that they agreed with my analyses (Glesne, 2006; Lincoln and Guba, 1985).

The researcher lived and worked in South Africa for two years. This allowed for an ethnographic exploration of the culture and issues of females in South Africa. As a result, ethnographic tools were employed in order to better understand the experiences of these females based upon the cultural context of post-Apartheid South Africa (Fetterman, 1998; Emerson, Fretz and Shaw, 1995).

The Journeys of Black South African Females for STEM Membership

At the time of the interview Ms. J and Manoko had been employed in their field for less than one year. On the day we met, Manoko was excited to share she had just received her first paycheck as an employee at the University. Reagilie and Phindiwe had been employed for over a year in their positions.

Narrative Voices of Participants

Case study of Ms. J

Ms. J comes from Limpopo from a Tsonga family of 6 from Limpopo in an area called Giysni, Section D1. There are two older boys she refers to as brothers who are her cousins raised by her parents after the death of their parents. She is the first-born child of her parents. She is followed by a sister who is 20 months younger, then by a much younger brother and a sister.

Beverly A King Miller

Her birth day and year was very significant for the future of the nation. She was born in 1990 the year that Mandela was freed from his 27-year imprisonment. Her birth date, March 21, is what has become Human Rights Day for the new democratic SA and is a national holiday.

Ms. J was privileged to go to private schools from her foundational years for all but the last three years of high school. These private schools were racially mixed. Describing her private school, she states:

> Since I was in a private school, we got opportunity to do community development and it was better than the public schools…I remember when I was growing up most of the children my age by about 1 o'clock they went home, and I was still in school. I didn't get home until around 5o'clock because after the normal classes they would make sure that after school you had to some extra activities whether its reading or sports or debate, you had to do something, homework as well…We had week long sleep over where we left Saturday. There is one we went to Pilgrims Rest in grade 6 I think we came to Joburg [Johannesburg], grade 7 we went to Cape Town. Every year there was a different trip.

Ms. J explained that as a student she had always enjoyed math and science. In high school she took accounting, biology, physical science, standard math and not math literacy (math literacy is a version of math that gives basic foundation but does not meet the requirements for university admission). In addition to these core courses, she studied Afrikaans and English languages. Her narrative reflects the ways in which her parents transgressed the offerings for a female child and ensured her advantages that she remembers as different from those who attended the public government schools. However, for high school she was moved to a public high school which disrupted her learning cycle. She explains:

> When I moved, I went from having 20 [students in a class] to 30 something in a class. …then I encountered the problem that my previous school they had divided up the syllabus. The first half of the year we did algebra and the second half geometry…. I moved in the middle of year and went to this other school and I found that in this second half…they did both physics and tomorrow its chemistry. And in math it was algebra and geometry. So that just messed me up because now I was perfect in algebra because of I did the whole syllabus for the year in 6 months, but geometry they are half way through the syllabus, and I don't even know where they started. The same in science, so that was hard.

This crucial shift prior to matric seems to be the reason for her resulting matric scores for diploma only. She had the option to retake the matric test to score higher to attend university to qualify for a bachelor's degree or diploma certificate degree. She started taking classes at the university toward a diploma certificate. She dropped out of the program when she found she was pregnant. It was at home after the birth of her child that she decided to investigate a Further Education and Training (FET) to get her diploma in engineering.

In South Africa all universities are government run and only they can grant university degrees (Bachelors, Masters or Ph.D.). However, Further Education and Training (FET) institutions and Technical and Vocational Education Training (TVET) institutions offer one to three-year programs in a training skill (Skillsportal, 2019).

Ms. J Journey to STEM

> I wish I had support from my parents and family going through studying. I didn't have that. It felt like I was on my own and everyone is just looking at me waiting for me to fail or drop out. No one had faith in me any longer for anything after I got my child. *Ms. J*

In Ms. J's office are 7 staff- 5 males and 2 females. Due to the ANC government requirement for the inclusion of Blacks, she is the third Black to be hired in this office. At the time of the interview, of the 54 building inspectors working for the City of Johannesburg only 7 are female. Ms. J's office and work area is in the city of Rooderpoort, a former Whites only section. The area of Johannesburg where she works are strong former Afrikaans communities; this is reflected in the fact that only 6 of the 13 communities have English names (Helderkruin, Kloofendal and Roodekrans- south Krans).

Her responsibilities are to ensure that buildings that are occupied by people meet the safety standards adopted by the City of Johannesburg. They must have architectural plans, electrical, fire and health certifications. She reads architectural plans to ensure that what they said they are building is what is on sight. This is because under Apartheid White families built inferior structures on their property for their Black workers (while shadowing her the researcher witnessed these small rooms without windows, bathrooms or running water).

Once these requirements are met, she stamps the approval for occupancy, and they may reside or conduct business in a given location. Once she leaves the office, she is independent and goes from site to site to conduct her inspections. For construction sites she wears a hard hat and boots- for home sites she carries the large file which include the architectural plans.

Ms. J explains that there is resistance by the builders and home owners at times to her authority due to her race and gender. Within these systems that had long excluded Blacks and other groups, Whites are still perceived as the authority. To support this, she offers an example of a client who preferred to hear the report from her White supervisor than from her- a young Black female.

Case study of Manoko

Manoko was an academically strong student from her start at Ga-Manamela Government School (Sub A-Standard 5 or Grade 1-7). She attended Maserole Secondary school for grades 8-12 or Standard 6-10. In 1999 she completed her matric with exemption (this is the highest level of passing for high school matriculates whereby they are eligible to attend any

university in the country). When reflecting on this achievement she states: 'I guess it came from discipline and my family".

Unfortunately, her family could not afford the university fees for the better universities. She would attend Vista University, the former Black university which is in the Township of Mamelodi outside Pretoria. Townships are the areas for Blacks that was established under the Apartheid regime. Pretoria is the capital city of South Africa.

Her family moved to the Black Township of Thembisa outside of Pretoria. Using the train system that took Blacks from the townships to the cities where Whites lived and worked, she travelled to Vista University. Her journey to the university started early in the morning when she would walk to the train. Once it arrived in Pretoria, she would take a second train. Finally, she would walk 25 minutes to the school. This trip took her almost 3 hours twice a day – 6 hours invested in travel to and from school. This reflected Manoko's commitment to her education.

Manoko attended Vista University because it was affordable. She received a bachelor's in chemistry and Statistics. After graduation she was not able to find a job. She was forced to take a job at a meat processing wholesaler where she was earning R50 ($4.50US) a day. After the sacrifice of paying her school fees she had to help the family with her younger brothers and sisters. In 2006 she returned to school at UNISA which offers part-time online courses. She worked towards her honors degree which is a bridge between a bachelors and a master's degree. Because of the demands from her job and having to work odd hours at the meat plant she discontinued her studies. In 2007 she quit her job to become a full-time student at the University of Limpopo. After successfully completing her honors degree that year, she pursued her master's degree at the University of The Witwatersrand, Johannesburg. She received scholarships to work on her master's and Ph.D. degrees.

Manoko Journey to STEM

> It's not that there was much to read to familiarize yourself. The teachers supplied what they could, we didn't have much I didn't have the guidance classes and all that…I didn't even know about Vista University until I got to Gauteng (Province). I only knew about Wits University and University of Pretoria. *Manoko*

Manoko earned her master's with distinction (*Cum Laude*) and later her Ph.D. in Chemistry, with an emphasis in Nanotechnology. She then received an appointment at this institution as a post-doctoral researcher. In 2015, at the time of this interview she had just completed one month in her full-time appointment as Senior Instrument Scientist in Microscopy and Microanalysis Unit.

Present Employment and Work Responsibilities

Her position as a Senior Instrument Scientist means that she is responsible for assisting postgraduate students (honors, masters and Ph.D.), postdoctoral fellows as well as researchers

from industry and other universities with their research and use of the electron microscopes at the University. Additionally, she supervises students and is required to publish research articles in her field. At the time she was working on a proposal for funding a research project that would address the energy crisis facing South Africa.

Case study of Reagile

Reagile is from the Tswana people of South Africa. She came from a family of 4 siblings; she has 2 sisters and one brother and she is the last born. She has one son and one great grand-child. Her family is from the Mabopane Township in Pretoria. Her mother was a domestic worker and her father worked at a factory making glass parts for cars. Their jobs meant the family had some economic stability.

Reagile shares that she wanted to be a pharmacist but she did not earn the matric scores to enter a degree program. She explains:

> I wanted to be a pharmacist… I can try to upgrade my results, but I didn't want to waste a year so I took my results to my tertiary and asked what I qualified to study. They said IT or computer science…I checked the subjects for computer science and here was like 25…and for IT there was like 7 subjects so that's how I got into IT.

Reagile graduated from the technical college but did not get a job in Information Technology (IT) for two years. It was actually her securing an internship at a company for Microsoft partners that opened her doors to IT. To redress the issues of Apartheid and give access to Black South Africans, many companies offer internship opportunities. They pay the worker only enough for transportation, but the worker performs all the tasks and works a regular 8 hour day.
She participated in this internship/training program for 7 months with the hope of a full time contract offer. Fortunately, she was one of the 15 out of 50 interns that the company employed for the 7 month period. Interestingly, she reported that prior to the 15 of them there were no Blacks at the company and even fewer females. She remained in this contractual position for two years and then applied for a post at Large University-1 in Johannesburg.

Reagile Journey to STEM

At the time of the interview Reagile worked as an SQL data base administrator in the IT department for Large Univeristy-1 in Johannesburg. (SQL is a Microsoft product that is used by the institution). At this institution she is in an office where three of the four are Black and half is female. Nevertheless for the IT technicians that serve the school at all campus locations, there are few females compared to the number of males. When asked about race, Reagile indicated that the department still had mostly Whites in the senior management, but that there were more Black managers coming on board as that population retires.

Work Responsibilities

At Large University-1 Reagile is responsible for monitoring the databases on the hundreds of servers that are on all campuses. She is responsible for 50 servers, but has information for all. The servers may include the information for human resource, student data or other departmental information. She checks to maintain space issues and also monitors for potential hackers. Throughout the day she constantly runs performance checks. She also monitors the Wi-Fi usage in different buildings inclusive of student housing to ensure that all connected have enough access. The four in her immediate office are responsible for network coverage 24 hours 7 days a week. They rotate being on-call in the evenings and weekends in case any problems arise. Her job does not allow for interaction with people, she is not a service technician, but rather a systems monitoring specialist. As such most of her time is spent looking at one of the two computer monitors found on her desk.

Case Study of Phindiwe

Phindiwe is originally from the rural area of Mthatha in the Eastern Cape. This is the area where Anti-Apartheid activists such as Mandela and Walter Susulu are from. Her father was a teacher by profession. He was trained at Bethel College an Adventist run institution. Her mother was trained in homeopathic medicine. However, after marriage she stayed home to raise the family. Later she worked in the department of foreign affairs. Her father is no longer living. She describes her family as not very traditional and was raised as Seventh Day Adventist.
Phindiwe is the 7th of 8 girls in her family. All of them have post matric (high school) education-one is a doctor, another lawyer, two are in education and the others are in business.

Phindiwe had wanted to study science and the field of dermatology. Her father was a teacher and knew the better schools in the region; he moved her to the better high school. She states: "Eastern Cape is very disadvantaged and this was the only school that had a [science] lab. It was good in math and science…matriculated with math and science." Although earning the matric scores for math and science, Phindiwe, did not have the overall scores for a university degree.

Unfortunately, she did not receive the academic guidance needed to fulfill her dream. She states at the time she did not understand bursaries and what that meant. She states: "there was no one to prepare you and tell you…for bursaries …you just know you want to be a dermatologist and I love biology…but you don't know what else you need like someone else to assist you." Due to financial constraints, she chose a local FET training program. It was with the guidance of her sister that she selected public relations as a focus. Her sister also cosigned the loan to pay her fees for this program.

Phindiwe Journey to STEM

At the end of her diploma program she was introduced to career opportunities in computers. She was encouraged to take a week long certification course in Cisco systems. In her first IT

position as a Network Administrator she noticed the shortage of women in the field. Of the 17 employed in the company there were only 3 women – she and 2 White women. In terms of racial identity, Phindiwe was the second Black– the other a male was employed as well. Using indices for race and gender, for this company she was in the minority. Phindiwe also added that Whites seemed to have been mostly Afrikaners and often spoke Afrikaans during meetings to the exclusion of their Black African employees who did not speak the language.

Work Responsibilities

Phindiwe is a Microsoft Infrastructure administrator. In this position she is responsible for monitoring the Internet servers, systems and database for the entire university. She shared that in this male dominated field she felt the need to 'prove myself'.

Phindiwe was recruited by Large University-1 and invited to interview for this position. She has been employed here for 3 years. She is responsible for the monitoring and maintenance of the entire system center. She sits in an office with three others. At her desk are two large computer screens. On one she is constantly monitoring the internet servers, she changes information within the system as needed by staff and faculty and creates new users for email access and other internal operations.

Discussion

In this section the findings from these narratives center on the following themes:
 1) Black females transgressing safety to acquire an education, 2) transgressing educational fees, 3) families transgress cultural norms to support their female children in their access to STEM careers and finally, 4) transgressing educational barriers in STEM.

Transgressing Physical Safety

In 2000 the South African murder rate for females was five times higher than the global average (Crimes Statistics Series Volume V, 2018). Gqola, (2015) ties rape of Black females to the Apartheid legacy where she says it was used as a weapon against females. The Apartheid justice system based on the Roman Dutch Law found Black females to be 'unrapable', therefore leaving them with no voice when indeed they had been raped by White or Black males. Gqola (2015) believes that this system that ignored the victimization of Black females has produced the present indifference for the safety of Black South African females; whereas Black and White men could be charged for raping a White female, no Black South African female under the Apartheid system could get justice for being raped (Gqola, 2015).

To study at the universities all participants had to leave their villages and communities in order to pursue their education. For South African Black females this is a safety issue. Ms. J further explains this by saying:

> I wish I was staying nearer to school so it would be a way to get around. I had to
> take two taxis or two buses in order to make it to school. And sometimes I had late

classes and study groups so I would have to walk quite a distance to get a taxi back home, also it would drop be far from home and I would have to walk at night and be scared in order to get home.

Given the high incidence of rape in South Africa and specifically against Black females, Ms. J was correct in her assessment of the situation. She had every right to be afraid in Johannesburg at night as a Black female college student. Manoko's six hour travel further typifies the distance that students who live in Black Townships must travel.

Transgressing Fees for Education

All four females encountered issues with financing their education. Ms J had parents who tried to pay her higher education fees and housing expenses. Manoko's family physically moves to be closer to Pretoria so she can have a place to live while she studies. Even with this move she has a 6-hour journey to and from school. Phindiwe's sister co-signed for her loan to pay for the certification program in public relations. Each family pays for the education in hopes that they will in turn help the other younger siblings. Manoko defers her dreams and works at a meat plant in order to provide economic support for her family and younger siblings.

Manoko's financial issues raises concern for the educational system because her matric scores deemed her qualified to be at any of the top institutions and work toward a degree and not a diploma, yet because of finances, she could not take advantage of this opportunity.

The burden on Black families to pay for education in addition to food, housing and clothing is one that limits many South African females access to higher education. The new #FeesMustFall movement is a call to redress the issue of the underrepresentation of qualified Black students on campuses due to the cost of university attendance (Mpofu-Walsh, 2016). Manoko was an academically strong student who struggled to complete her studies due to an educational fee structure designed to support a European educational model. It is unrealistic to believe that those shut out economically will be able to obtain the funds needed to send their children to college.

The #FeesMustFall Movement of 2015 is a reflection that Black college students are transgressing these norms that affected these females. The movement challenges university fees demanded from poor Black families (Booysen, 2016). It further challenges the inequity that service workers, who are primarily Black are unable to receive tuition waivers for their offspring's (Booysen, 2016). These burdens faced by academically gifted Black students like Manoko, are now being challenged by those who were born under a democratic governmental South Africa.

Family Transgressions

Educational institutions were not conveniently located in townships or the countryside. Many students like Ms. J had to find a place to live in Johannesburg to be near universities. Black

Beverly A King Miller

South Africans do not have quality universities near their Townships or rural communities. None of the parents could understand what their daughters were studying – engineering, chemistry, and statistics were unfamiliar disciplines compared to nursing and teaching. Yet, they supported them with their meager finances.

Manoko's parents are representative of the many Black Africans under Apartheid who received limited education. Her mother was educated through Standard 6 (about Grade 8) and her father through Standard 2 (about grade 4). Yet, her parents were committed to seeing their children educated and worked to support each in this endeavor.

Phindiwe shares that her father, as a teacher, found the best schools for them to attend. This meant getting up at 4 am to travel to school. He sought out the high school with the science lab in order to support her dream of being a dermatologist. With such intentionality, it is no surprise that all of her siblings have a post matric diploma or a university degree (i.e. doctor, lawyer).

These females determined to transgress the system. Ms. J decided as a single parent to begin an engineering program. Her parents would also transgress the cultural norms by taking care of her child while she returned to Johannesburg to begin her studies. In the next sections, these STEM females share the level of transgression needed to overcome an educational system that did not adequately train them for higher education.

Transgressing Educational Barriers to STEM

Three of the four females interviewed voiced that they did not earn the matric scores to qualify to study for a degree program. Reagile, did not qualify in math and science so could not study for a degree in the sciences. She chose to settle for an alternative program of study so as not to sit out for a year retaking the exam components. This quasi time of retaking the exam can also be detrimental for students. They are not university or FET students, nor are they high school students. Ms J became pregnant during this transition time.

The issue that surfaces here is why was seventy-five percent of the participants unprepared for university to study what they had hoped for? Under-preparedness of students from Black Townships is a major concern in South Africa. Phindiwe is a reflection of issues sited in the Eastern Cape where in 2014 only 20% of Eastern Cape high school graduates passed meeting the university admission for a Bachelor's degree (Pillay, 2017).

In both Phindiwe and Reagile, they ended up in career pathways that were not of their choosing. Academic programs are needed that support the educational system and provide remediation to struggling students and enrichment to capable students not exposed to STEM content. Although, the schools they attended were deemed 'better' they were not Model C schools so they lack the successful throughput which is evidenced by their ineffectiveness.

The University of South Africa has begun a program called *GirlPower* that proposes to address the need of underrepresented girls in science, engineering and technology (SET)

(Williams, 2016). This program seeks to increase the confidence and competence in local girls so that they can compete in a research summit demonstrating presentation skills. Okeke-Ihejirka, (2009, 209) suggest that "Higher education not only holds the potential to lift women above the poverty line but could also thrust them into enviable economic positions far above their less-educated peers of both genders. Such a comfortable status is likely to afford them the space and means to make decisions about their lives; decisions that would probably otherwise be left in the hands of others".

Conclusion

The narratives demonstrate the level of sacrifice and commitment that Black South African females endure in order to achieve their educational goals. They sacrifice personal safety and transgress the norms of gender and race to complete the requirements for higher education training. Higher education institutions in South Africa are challenged to transgress the ways in which the institutions serve its majority Black population. Consideration for the physical safety needs of Black South African females may include opening quality institutions near Black Townships to resolve the migration of Black females to cities like Johannesburg and Pretoria.

Second, many Black African families do not have the resources to support a university student while simultaneously supporting a household. The narratives demonstrate the level of sacrifice that Black African families endure in order to see their female children educated. They transgress cultural and economic systems in order to have their daughters gain access to STEM careers and the economic stability that it provides. The #FEESMUSTFALL initiative of 2015 is a call to redress the inequities embedded in a system that was designed to exclude Black South Africans.

Finally, academic programs that support the educational system is needed. Programs like *GirlPower* promote female empowerment through competition and skill building. Such programs offer enrichment opportunities and remediation. STEM related competitions help students to apply their knowledge in competitive arenas by integrating math and science through real life applications.

Without access to higher education the masses of Black South Africans remain excluded from the global STEM market. Recently, Manoko was awarded a Fulbright Fellowship. She will now represent South Africa as a member of this elite group of research scholars. How many academically talented females remain in Black Townships because of socio-economic or socio-cultural barriers? One is too many.

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