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Factors Motivating Black Female Learners to Enroll in STEM Streams and Their Strategies to Cope with the Curriculum: A Qualitative Inquiry in a South African Secondary School

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Abstract: Participation in science, technology, engineering, and mathematics (STEM) fields is crucial, as these fields present an opportunity for individuals to overcome socio-economic adversities such as unemployment and poverty. In South Africa, access to STEM education has improved in recent years, partly due to the availability of study grants for learners interested in these fields. However, evidence shows that women remain underrepresented in STEM fields. Gender stereotypes, bullying, and pay disparities are cited as some of the contributing factors. Despite these overwhelming challenges, female learners are increasingly pursuing STEM education. Guided by the resilience theory, we explored the factors motivating female learners to enroll in STEM fields at a public secondary school level in South Africa. The research adopted the snowball sampling technique to recruit learners attending a public secondary school in South Africa. Due to COVID-19-related restrictions in 2022, the research data was collected through telephonic one-on-one interviews. The findings revealed that access to competitive employment opportunities, impactful careers, personal growth, and financial independence were some factors sparking the female learners' interest in STEM. However, the learners experienced gender stereotypes and discrimination, which made them doubt their abilities to thrive in STEM education/fields. To cope with the complexities of STEM, the learners relied on their caregivers for emotional support, and they attended extra lessons and tutorials offered by the education system. The findings highlight the need for the government to prioritize support programs for female learners who must continuously fight rejection in STEM fields.

Keywords: STEM; motivating factors; female learners; secondary school; gender stereotypes; support; South Africa

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1. Introduction

Globally, studies have shown that participation in science, technology, engineering, and mathematics (STEM) is crucial, as STEM fields present opportunities to overcome socioeconomic adversities. For example, STEM graduates tend to have increased access to jobs and economic empowerment opportunities which are rarely accessible by non-STEM graduates (Carnevale et al., 2011; Hansen et al., 2024; Mujtaba et al., 2018; Walker, 2015; Widayanti & Suyatna, 2019). STEM education not only has the potential to reduce poverty and inequality but also equips students with scarce skills for the modern workforce. These skills allow graduates to address pressing social and economic issues and

contribute to sustainable development in their countries (Popo-Olaniyan et al., 2022). Ultimately, the benefits of STEM education extend beyond the individual by empowering learners/graduates to make meaningful contributions to the development of their countries. Gender parity in STEM education should be supported across all levels of society (Chan, 2022; Casad et al., 2021). So, females and males have equal opportunities in STEM fields. However, in the realm of the literature, it is often noted that women who pursue careers in STEM fields face lower levels of acceptance (Babalola et al., 2021), aggression, bullying, and harassment, which are often perpetrated by males (O'Connell & McKinnon, 2021; Kim & Meister, 2023), and the pay gap compared to their male counterparts further contributes to making the field hostile toward women (Xu, 2015; Zając et al., 2025). The disproportionate gender balance in STEM undermines the United Nations Sustainable Development Goals (SDGs) 4 and 5. For example, SDG 5 stands for gender equality, with a particular focus on the empowerment of women and children and the improved representation of women in leadership positions. Increasing women's participation in STEM, especially in the era of artificial intelligence, could enhance their representation in traditionally male-dominated fields such as engineering.

2. Background

Over the years, a significant body of research has examined the key factors that discourage female students from pursuing education and careers in STEM fields (Ardura & Pérez-Bitrián, 2018; Blustein et al., 2022; Wang et al., 2022). Warsito et al. (2023) state that gender stereotypes make it difficult for some women to enter STEM fields. In many societies, STEM fields such as mathematics, engineering, and computer sciences are marketed as male fields (Riegle-Crumb & Morton, 2017). Women are conditioned to pursue nurturing careers such as nursing and social work. Riegle-Crumb and Morton (2017) argue that from a young age, women are exposed to messages that undermine their abilities and confidence in STEM careers. Studies have shown that exclusionary messages, for example, "you can't be good in mathematics", from caregivers and educators negatively affect females' self-confidence (Riegle-Crumb & Morton, 2017; Master & Meltzoff, 2016).

In the last decade, gender disparity in STEM has received attention seen through increased mentorship for women in STEM and funding support. However, despite these efforts to reduce the disparities, the number of women in the space remains relatively low. Warsito et al. (2023) argue that early exposure to learning opportunities, mentorship, and female role models is important in retaining females in STEM fields. However, this remains a challenge in many societies due to systematic challenges such as the unequal distribution of resources, gender discrimination, and the attitudes of significant others (e.g., parents and educators), which makes females assume that STEM fields are suited for males (Master & Meltzoff, 2016). In the height of artificial intelligence (AI), STEM careers are advantageous due to ample opportunities, demand for professionals with a set of skills, and career advancement opportunities. Women should be encouraged and supported to enter STEM fields in greater numbers to contribute to national development through technological and medical innovations.

Studies also reveal that parental influence and social support play a crucial role in motivating students to pursue a STEM career (Šimunović & Babarović, 2020; Thomas & Strunk, 2017). Dennehy and Dasgupta (2017) state that the presence of supportive role models has a profound impact, inspiring students to persist in their studies and strive for success. These role models not only offer guidance but also help to reinforce the belief that STEM careers are both attainable and rewarding (Shin et al., 2016). Many learners, particularly those from underprivileged backgrounds, pursue STEM education to acquire skills and later secure stable employment (Bacovic et al., 2022; Yaki et al., 2021).

However, STEM education comes with a myriad of challenges. In under-served public schools, learners often encounter various challenges such as a lack of resources, a lack of diversity in STEM fields, or inadequate qualified teachers (Peterson, 2016; Riley et al., 2013). As a result, female learners must often battle these systematic challenges and stereotypes which regularly question their cultural fit and ability. There is a need for countries to introduce or strengthen support programs for females interested in STEM careers. South Africa like many other low- and middle-income countries is struggling to bridge the gap in STEM fields (Abe & Chikoko, 2020; Jaga et al., 2018). A study by the Planet Earth Institute (2016) showed that only 1 in 10 secondary learners considered studying STEM at the university level. Further, most male and female learners in the South African basic education system opt for general subjects due to stereotypes associated with STEM fields (Sikhosana et al., 2023). The government's poor investment in schooling infrastructure and the shortage of STEM educators are some of the factors contributing to learners' poor uptake of STEM subjects and performance (Sikhosana et al., 2025).

3. Black Female Learners and Resilience

This paper utilizes resiliency as a lens to analyze the coping strategies adopted by black female learners studying STEM subjects in South Africa. Resilience theory has emerged as an essential framework for understanding how individuals, communities, and systems adapt to adversity (Wu et al., 2013). Initially rooted in psychological studies, it has expanded to encompass various domains, including sociology, social work, and health. The core premise of resilience theory is that despite experiencing significant stressors or challenges in one's life, such as trauma and disasters, people possess the capacity to recover, adapt, and thrive (Herrman et al., 2011; Wu et al., 2013; Zimmerman, 2013). Zimmerman (2013) further notes that "Resiliency focuses attention on positive contextual, social, and individual variables that interfere or disrupt developmental trajectories from risk to problem behaviors, mental distress, and poor health outcomes" (p. 1). Scholars such as Brennan (2008) also posit that resilience theory tries to explain the ability to withstand shocks, without those shocks significantly compromising one's function. Hence, this theory adopts a strength-based approach to understanding vulnerability. This theory asserts that people have strengths, and despite the overwhelming challenges they face, they also have assets to resist or cope with these challenges (Herrman et al., 2011; Mustari & Karim, 2015; Woods-Giscombe et al., 2023; Wu et al., 2013). At its core, resilience theory posits that resilience is not merely a trait but a dynamic process that involves the interaction between an individual and their environment (Beauboeuf-Lafontant, 2007).

Resiliency theory focuses on the capacity of individuals to thrive and overcome adversity despite challenging circumstances (Herrman et al., 2011; Mustari & Karim, 2015). This theory emphasizes the role of protective factors such as supportive peer and family relationships, positive role models, and personal strengths that foster resilience (Burt & Paysnick, 2012; Estêvão et al., 2017; Jones et al., 2016; Wu et al., 2013; Zimmerman, 2013). Woods-Giscombe et al. (2023) further note that to fully understand resilience, there is a need to analyze the stressors that are associated with it. They argue that resilience is shaped by adversities such as structural injustice, historical violence, and oppression based on multiple intersecting identities such as race, class, sexuality, and gender (Woods-Giscombe et al., 2023). This theory has also gained popularity in feminist and intersectional research, especially research focusing on the interplay of race, class, and gender among black women (Beauboeuf-Lafontant, 2007; Woods-Giscombe et al., 2023).

In the context of black female learners, research shows that black female learners face a myriad of challenges in the South African education system because of their identities as black women (Keswell, 2010; Kricorian et al., 2020; Modisaotsile et al., 2023;

Sikhosana et al., 2023). Scholars further recognize that despite these intersecting identities of oppression that shape the lives of these black learners, especially women, they manage to overcome these experiences and thrive (Beauboeuf-Lafontant, 2007; Jefferis & Theron, 2017; Matukane & Bronkhorst, 2017; Theron, 2013; Wills & Hofmeyr, 2019). Hence, the resiliency theory aided in identifying pathways to success by highlighting the factors that enabled female learners in STEM fields to navigate and triumph despite barriers to participation and success in STEM subjects. Furthermore, the application of resiliency theory provided a framework to explore and enhance the protective factors that can support black female learners' journeys in STEM subjects. Understanding how resilience functions in educational settings can inform interventions that empower learners to overcome systemic and personal challenges. It can also aid in nurturing self-efficacy and motivation, which are critical for persistence in STEM subjects.

4. Research Aim

The research aims to contribute to knowledge and debates on women's experiences in STEM fields by offering insights into the factors that encourage underprivileged female learners to pursue careers in STEM fields, as well as the strategies they use to navigate the demanding nature of the STEM curriculum. The research was guided by these research questions:

- Research Question 1 (RQ1): What factors encouraged female learners to enroll in STEM fields?
- Research Question 2 (RQ 2): What coping strategies do the learners employ to manage or cope in the STEM fields?

5. Materials and Methods

5.1. Research Design

To explore the learners' motivations for pursuing STEM education, we adopted a phenomenological qualitative research design. Creswell (2009) states that qualitative research is vested in exploring participants' experiences of a phenomenon or situation. The researchers were vested in understanding the learner's lived experiences of STEM education, with a focus on the factors that encouraged them to pursue STEM education as well as the strategies they used to manage the complex STEM curriculum. The qualitative design enabled the learners to share their unique experiences of STEM education.

5.2. Research Context and Sample

The research was undertaken in a public secondary school located in the Soweto township. Soweto is one of the oldest and most diverse townships in South Africa with a rapidly expanding population. In 2024, the township population was estimated at 1,895,921 (Statistics South Africa, 2024). The researchers were interested in female learners enrolled in STEM subjects such as mathematics, physical sciences, and engineering graphics and design (Table 1). The learners who participated in the research were between 15 and 18 years old and in grade 10. We focused on grade 10 learners, as the South African basic education framework requires students to choose between the science, commerce, and general streams at this stage.

The learners' recruitment started during the height of the COVID-19 waves in 2022. Due to travel and human contact restrictions imposed by the South African government to curb the spread of the virus (Ramrathan, 2021; Maree, 2022), the lead author (HS) encountered difficulties in accessing the school to recruit the learners. Snowball sampling, a technique traditionally used when participants are scarce or hard to identify, was employed to recruit learners (Alston & Bowles, 2003). Utilizing the limited opportunities to interact

with the learners, HS recruited one learner who then assisted in the recruitment of more learners who met the research inclusion criteria. To be included in the study, learners had to fulfill the following inclusion criteria:

- The learner must be a black female.
- Be between the ages of 15 and 18 years.
- Be enrolled in one or more STEM subjects at a public secondary school.
- Learners in nearby secondary schools and enrolled in non-STEM subjects were excluded from participating in the research.

Table 1. Learners' educational demographics.

Participant Code	Age	Grade	STEM Subjects
1	15	10	Technical science, technical math, and engineering graphics and design
2	17	10	Technical science, technical math, and engineering graphics and design
3	17	10	Physical science and pure math
4	15	10	Physical science and pure math
5	18	10	Physical science and pure math
6	16	10	Physical science and pure math
7	16	10	Physical science and pure math
8	17	10	Physical science and pure math
9	16	10	Technical science, technical math, and engineering graphics and design
10	16	10	Technical science, technical math, engineering graphics and design, and construction

5.3. Ethics and Data Collection

Ethical clearance was obtained from the University of the Witwatersrand HREC Non-Medical Committee (Protocol number: H21/03/25). The Gauteng Provincial Department of Basic Education and the school government body also provided written approval for the research to be undertaken in the school. Since the sample included underage learners (15–17 years), caregivers were engaged to provide consent for the learners to participate in audio-recorded interviews.

The data was collected using semi-structured one-on-one telephonic interviews. The initial plan was to collect data in person; however, the COVID-19-related restrictions made it difficult for the first author to access the school to recruit and interview the learners. During the interviews, the learners were asked questions about their experiences of STEM education, motivation for enrolling in STEM subjects, the challenges they encountered in their studies, and their coping mechanisms. Though telephonic interviews helped the researcher overcome the COVID-19-related restrictions, the method also presented numerous challenges (Johnson et al., 2021). For example, it was difficult to study the learners' non-verbal cues and probe some of their responses due to time restrictions. To minimize the possibility of disrupting the learners in their studies, interviews were conducted after school hours. Each interview lasted approximately 40 min.

5.4. Data Analysis

We followed Braun and Clarke's (2012) thematic analysis method to analyze the data, which involves identifying, organizing, and establishing patterns in qualitative data.

Phase 1: Familiarization with the data

Following the interviews, the audio recordings were transcribed verbatim to ensure accuracy and the retention of participants' original expressions. The first author then immersed herself in the data by reading and re-reading the transcripts multiple times.

Phase 2: Generating initial codes

Each transcript was coded line by line. This step involved systematically identifying and labeling units of meaning that captured relevant features of the data. The codes reflected both the explicit statements of learners and the underlying meanings. For example, statements about choosing STEM for better job prospects were initially coded under "job security" and "career aspirations".

Phase 3: Searching for themes

After all the transcripts were coded, the first author collated similar codes and began the process of identifying broader patterns or themes. Related codes were grouped under preliminary theme categories, and visual representations (tables) were created to explore the relationships between the codes. It was at this stage that two primary themes were constructed: learners' motivations to pursue education in STEM and strategies employed by the learners to cope with the demand of STEM education (Table 2).

Table 2. Themes and subthemes.

	Themes		Subthemes	Internal/External Drivers
1.	Learners' motivations to pursue education in STEM	1.1	Employment opportunities	External
		1.2	Impactful and rewarding career	External
		1.3	Professional growth	Internal
		1.4	Empowerment and financial independence	Internal
2.	Strategies employed by the learners to cope with the demand of STEM education	2.1	Extra lessons	External
		2.2	Peer tutorial and mentorship	External
		2.3	Parental motivation	External

Phase 4: Reviewing themes

The research team met to discuss, review, and refine the preliminary themes and subthemes. Each theme was assessed in relation to the coded data extracts and the entire dataset to ensure consistency. The subthemes—such as employment opportunities, an impactful and rewarding career, and peer tutorial and mentorship—were verified as representative of recurring patterns that were substantively meaningful (Table 2).

Phase 5: Defining and naming themes

The themes were clearly defined and named. Descriptive summaries were written for each theme and subtheme to articulate the story each one told in relation to the research questions. For example, the theme "learners' motivations to pursue education in STEM" covers various drivers such as the desire for professional growth, empowerment, and financial independence.

5.5. Establishing Research Trustworthiness

Lincoln and Guba (1986) identified credibility, transferability, dependability, and confirmability as key concepts that qualitative researchers should strive to deliberate on to achieve research trustworthiness. The audio recordings of the interviews were listened to, transcribed verbatim, and reviewed to address errors and inconsistencies (credibility). There were also regular engagements between the authors to discuss the patterns of the data and agree on emerging themes (confirmability). Furthermore, the researchers provided a rich description of the study context, research design, data collection methods used, and challenges encountered in the study (confirmability and transferability).

6. Results

The findings are presented using two broad themes: (1) learners' motivations to pursue STEM education and (2) strategies employed by the learners to cope with the demand of STEM education. We further distinguish between the internal and external dimensions of each subtheme. This classification indicates whether a specific factor is based on the learner's personal characteristics, such as intrinsic motivation, identity, or self-perception, or on external contexts, such as structural conditions, social dynamics, or institutional influences. By defining these characteristics, the analysis provides a more comprehensive understanding of how human agency and environmental circumstances influence learners' experiences and participation in STEM education.

6.1. Theme 1: Learners' Motivations to Pursue STEM Education

We explored the learners' motivations to enroll in STEM education. Many of the learners highlighted employment opportunities for those with knowledge on STEM subjects, diverse career paths, and guaranteed professional development and growth in the future as motivating factors. These subthemes are described in detail below.

6.1.1. Subtheme 1: Employment Opportunities

Many of the learners were from needy families and raised by unemployed and underskilled parents/caregivers. The learners mentioned that they enrolled in STEM to avoid the unemployment trap which affects many youths in South Africa. In 2022, Statistics South Africa reported an unemployment rate of 42.1% for those aged 15–24 (Statistics South Africa, 2022). The learners were of the view that STEM education would provide them with the necessary knowledge and skills to be competitive in the labor market.

> "The area I live in has RDP houses and most people in the area are unemployed. My parents are unemployed. I once did research about engineering subjects as I was looking into which subjects I should take, and I noted that engineering has a lot of opportunities. In my neighborhood, there is a lot of young people who are not working, and I don't want to be like them. I want to work and help my family". (Participant 1)

> "I intend to be a doctor so that I can get a good paying Job and help people". (Participant 8)

Despite the shortage of STEM graduates in South Africa, the burden of unemployment is affecting many graduates (including those with STEM qualifications). As a result, some learners added that with the knowledge and skills they have gained from STEM education, they intend to open businesses.

> "I love construction Mam; it is all about hard work and I feel like with the skill gained there, you will be able to start something and work with your hands even when you cannot find employment". (Participant 10)

> "Yes, there are a lot of opportunities in STEM and again you will be able to help people in your community. For example, in construction you can gain a skill of building and be able to build a roof for your family or start your own small business with that skill and help build around the community". (Participant 7)

It is evident that the learners were aware of external factors, such as a struggling economy, which negatively impacted job availability. As a result, some participants expressed intentions to start their own businesses after obtaining their STEM qualifications.

6.1.2. Subtheme 2: An Impactful and Rewarding Career

In addition to securing employment, some of the learners were interested in joining sectors with a direct impact on society's functioning such as medicine. These learners aspired to become medical doctors so that they could cure sick people.

> "I want to become a doctor because I want to help people". I was thinking of being a doctor so that I can help people. I just want to see myself helping people. Alternatively, I would like to be a social worker so I can help people living in poverty because I am also in that condition, and it is my wish to help change people's lives". (Participant 4)

Within the South African education system, for learners to be admitted into a medical program, they need STEM subjects, which include mathematics, physical, and life sciences.

> "I see myself one day having my own surgery and being a doctor. I reside with my grandmother who smokes and drinks a lot. When I was young, I would ask at school if it was good for my grandmother to smoke and drink in her condition. Her condition and behavior worry me, and my wish is for her to live long until I get to be a doctor so I can help her with her". (Participant 6)

Being enrolled in a medical school serves as an external motivation for many learners, as medical degrees are seen as pathways to numerous opportunities and well-paying jobs.

6.1.3. Subtheme 3: Professional Growth

STEM education integrates practical and laboratory hours. In the current research, the learners enjoyed undertaking practical work and participating in laboratories. They felt that their involvement in these activities helped them obtain new knowledge and build much-needed skills. In emphasizing this, Participant 9 stated, "Yes, I think the knowledge provided is stimulating my growth but difficult". Participant 7 indicated, "Because they give you new and rare knowledge. Even though at first it seems difficult, and you do not know the content but eventually if you are interested enough, you will know". Another participant further expounded that,

> "These subjects are not only based on theory but also practical. For example, with these subjects you can even start your business and help within communities. Even at home, you will be able to help when there is a burst pipe. You grow from these subjects". (Participant 8)

As captured by the above, the learners appreciated the opportunity to acquire knowledge and skills, and they expressed a clear awareness that this knowledge would be beneficial to them soon. These findings further highlight the significance of STEM education in developing societies and economies.

6.1.4. Subtheme 4: Empowerment and Financial Independence

As mentioned earlier, many of the learners were raised in poor backgrounds. They had first-hand experience of poverty and unemployment. These learners did not want to be stuck like some of their family members and community members; they wanted something different for themselves. These learners enrolled into STEM classes to empower themselves with an education that would enable them to study toward a career that is in demand and guaranteed employment upon completion.

> "I want to make my own money. I just want to be Independent. I want to own my own construction business. I always feel bad when I see women reliant on men in my township because someone can die or abuse you and then if you

> break up with them you end up being stranded, I do not want to be stranded". (Participant 2)

The learners further showed a good understanding of careers in demand. They continuously referenced computer sciences, medicine, and engineering as their key out of poverty. Despite their structural disadvantages, these learners were motivated to pursue careers in high-demand fields to increase their chances of securing good jobs upon graduation. A participant commented: "Information technology pays well. SinceI am doing these subjects, I want to pursue it. Women are not economically empowered where I stay. Here most women are abused by the partners, we also have the electricity issue. Women have tried to fight for electricity and men would argue that they would not be ruled by women so they silent women voice despite women having equal right to fight for electricity" (Participant 5).

> "I stay in a shack. Both my parents are unemployed but are very supportive of me and my studies. I would like to do medicine or something within science. Science careers have more job opportunities. I think we need to know about science, I think it is important, and I want to know more about medicine as well". (Participant 3)

The learners were of the view that if they had critical subjects such as mathematics and physical sciences, they would be one step closer to financial independence. Equipped with these subjects, they will be able to enroll in high-demand courses after completing their matric. "If you have mathematics and science, you stand a good chance to get a job that is paying well, and many jobs require physical science and mathematics. This is what I learned from university prospects. In my community, most women are dependent on their partners and do not work" (Participant 7).

It was evident that many of the learners viewed STEM subjects as a ladder to personal development and a pathway to success in the future. However, although this group of learners was determined to pursue STEM careers, they encountered a myriad of debilitating challenges. These included persistent gender stereotypes and a lack of resources to support their learning. In the next section, we highlight how the learners navigated these obstacles.

6.2. Theme 2: Strategies Employed by the Learners to Cope with the Demand of STEM Education

The learners employed various strategies to cope with the demands of the STEM curriculum. Most relied on extra lessons provided by their schools, peer tutoring, and mentorship. Parents also played a crucial role in keeping the learners motivated despite the challenges they faced.

6.2.1. Subtheme 1: Extra Lessons

The learners reported a myriad of difficulties in their science subjects. This included difficulties in understanding mathematical concepts and technical activities such as drawing. To overcome these difficulties, the learners participated in extra lesson sessions organized by their educators and external parties, which helped them better comprehend the topics and find solutions.

> "It has been difficult. I was assisted by the fact that I attend extra lessons otherwise it would have been difficult. For mathematics, I got 60% and for physical science, I got 50% and I would say I am grateful to my mathematics teacher for giving us extra lessons and releasing us late". (Participant 3)

The learners explained that since joining extra lessons offered by external institutions, they had seen improvements in their grades and consistently stayed ahead of the curriculum.

> "I have my own extra classes which I take for mathematics, engineering, and technical science. Extra classes are very helpful because I am always ahead in class. You find that the teacher is doing a topic which I have already covered so it does help". (Participant 1)

Most of the academic support the learners received came from external sources, which required payment to access. This made it difficult for some learners, particularly those from disadvantaged backgrounds, to benefit from these programs. In addition, anecdotal evidence from the height of the COVID-19 pandemic suggests that learners faced difficulties when participating in extra classes due to social distancing measures implemented to curb the spread of the virus. These factors may have shaped learners' experiences of academic support.

6.2.2. Subtheme 2: Peer Tutorial Support and Mentorship

Learners who could not afford formal tutorial support services relied on close associates, such as siblings and neighbors who had recently completed school, to help them manage their subjects. After school, the learners consulted these parties to explain complex mathematical problems and help them find solutions. Participant 3 explained, "I have an older sister who studied the same subjects I am doing now, and she inspires me so much". Participant 4 supported this view, stating, "My neighbor did these subjects and really motivates me; he is currently at University".

These learners appreciated being assisted by peers who had walked the same path before and succeeded. The learners felt encouraged, and their interest in STEM education was reinforced through interactions with individuals who had previously studied the same subjects. "When it comes to help ma'am, there are these girls which are doing their third year at university, they were doing these subjects that I am doing, and they really help me with knowledge. These girls are twins; they help me but often they have a lot of work" (Participant 10).

These informal forms of academic support ensured that learners in need, but without financial resources, could still access the help necessary to succeed in STEM education. Though these former high school learners and university students dedicated time and resources to helping the learners cope with the evolving STEM curriculum, their support was not sustainable.

6.2.3. Subtheme 3: Parental Involvement

In addition, the participants also drew strength from their parents and caregivers. Some parents of the participants recognized the value of education and regularly encouraged their children to remain committed to their chosen field of study and accompanied them to career exposition events. The subtheme was captured when Participants 5 and 9 said,

> "My mom would always encourage that I choose subjects that would help me to be well off in life. She would encourage me to do maths because she saw that maths is something that I love, and she would greatly support me by paying tutors to come and assist me". (Participant 5)

> "Mhm, I was with my mom, and we went to this career expo, and they explained more about these careers, and my mom also plays a vital role in supporting me by giving me more time to study so that I can meet the academic point score (APS) score that I need". (Participant 9)

Some parents, in support of their children's education, purchased learning equipment for them. Participant 7 alluded that her father bought her a computer so that she could

perfect her knowledge of computers. This occurred after the participant demonstrated an interest in pursuing a computer science field following secondary school education.

Furthermore, some parents helped guide their children to fields or careers that were in demand such as medicine. A learner who was encouraged to consider medicine as a career commented the following: "He (father) told me that this career is rare because a lot of people do not want to study for a long time. They just want to study 3 to 4 years" (Participant 8). In the South African context, entering a medical school is competitive, and once admitted the course takes 6 years to complete. Although the training takes a few years, once completed, graduates have a good chance of securing well-paying jobs in either the public or private sector.

This data therefore shows the significant role that parents play in education. The learners, apart from their interests in pursuing STEM education, also felt supported by their parents. This helped fuel their drive to persist even when faced with difficulties. However, these findings should be understood within the context of the COVID-19 pandemic, as the research was conducted during a time when education systems were severely disrupted.

7. Discussions

The study investigated the factors contributing to black female learners' enrolment in STEM and the strategies they used to cope with the demanding curriculum. The findings revealed that the learners enrolled in STEM with their future in mind. These learners wanted to have access to fields with opportunities such as medicine and engineering, positions with decent remuneration, and other developmental opportunities. This proactive approach to resilience is seen in this forward-looking mindset, where learners are proactively placing themselves within a difficult system to achieve better futures rather than just responding to hardships (Ungar, 2011). Such agency needs to be seen from an intersectional perspective, considering how class, gender, and race all work together to influence the obstacles learners face (Collins & Bilge, 2016; Sikhosana et al., 2023).

However, the learner's stay in STEM was not without challenges. The researchers reported elsewhere that the learners had to continuously navigate social–gender stereotypes and the lack of learning facilities, which affected their productivity in STEM education (Sikhosana et al., 2025). These challenges, while structural, demanded adaptive responses that demonstrate both personal and collective resilience. To cope with the complex STEM curriculum, the learners made use of tutorials and mentorship support outside the education system.

For decades, the literature has attributed women's underrepresentation in STEM to gender stereotypes and discrimination (Cundiff et al., 2018; Ertl et al., 2017; Moè et al., 2021; Stout et al., 2016). In the South African context, reports show that some women are thriving in the engineering, medicine, and technology fields (Women in Science, 2023). Women in Science (2023) credited the expansion of education opportunities, changing gender roles that previously limited women's access to opportunities, and the availability of female role models as some of the factors contributing to the increase in the participation of women in STEM (Herrmann et al., 2016; Women in Science, 2023). In the present study, the learners were similarly determined to continue their STEM education despite the magnitude of challenges they faced. To keep up with the complex and evolving curriculum, the participants sought guidance from peer tutors and educators while also relying on the emotional support they received from parents. This is an example of "relational resilience", in which students use social networks to mitigate the negative impacts of educational disparities (Theron & Theron, 2010). The students' use of tutorials and mentorship can also be seen as a positive form of adaptation in the face of adversity, as described by Hunsu et al. (2021). This shows how resilience is not just an individual

trait but a socially embedded process that draws strength from family, peers, and informal networks (Ungar, 2011).

Scholars have identified higher earning potential and the desire to challenge gender stereotypes as key reasons why women continue to pursue STEM careers despite facing significant challenges (Estrada et al., 2018; Women in Science, 2023; Zaniewski & Reinholz, 2016). In the changing world, countries such as South Africa are under pressure to keep up with the Fourth Industrial Revolution which requires the integration of technologies in key industries (Bayode et al., 2019; Fomunyam, 2019). In recent years it has become apparent that countries need to leverage STEM and the Fourth Industrial Revolution. The interest of the participants in pursuing STEM education should be supported on all fronts. Although these macro-level imperatives justify more extensive policy investment in STEM, the lived experiences of black female students highlight the need for institutional changes that address the exacerbated obstacles brought about by interlocking forms of discrimination (Collins & Bilge, 2016). To ensure the availability of future innovators, the academic resilience of these students should be complemented with programs aimed at eradicating gender stereotypes, as well as institutional support such as mentorship.

Women must be encouraged to enter STEM fields in greater numbers across all areas. Increasing the participation of women in STEM fields can enhance the economic empowerment of women because STEM fields are often associated with better-paying jobs (Ruiz-Cantisani et al., 2021; Xhindi & Gjika, 2022). Duflo's (2012) paper also highlights that scholars subscribing to the efficiency approach argue that empowering women is strongly linked to development; if more women are given access to education and occupy key decision-making positions in families, institutions, and policy positions, then there are higher chances of lower rates of child mortality, improved family wellbeing, and ultimately development. This aligns with SDGs 4 and 5, which emphasize access to quality education and gender equality. Nevertheless, efforts to promote STEM inclusiveness risk perpetuating inequality if they overlook the unique experiences of women, especially those at the intersection of racial and economic disadvantage. Therefore, the resilience demonstrated by this study's participants should be understood not only as persistence but also as resistance to systemic exclusion. Hence, this paper underscores the need to promote coping strategies and incubate resilience to foster women participation in STEM fields.

Furthermore, this study found that mentorship provided by peers, school seniors, and family members was a crucial form of support for black female learners, especially those who could not afford professional tutors. A review of the evidence indicated that mentorship plays a key role in shaping a positive trajectory for undergraduate black women studying STEM programs at universities (Dickens, 2021). Similarly, Dajani et al. (2021) and Dasgupta and Stout (2014) found that mentorship increased the chances of women excelling in their STEM careers. Scholars have further discussed the important role of mentorship in building resilience among learners (Dajani et al., 2021; Dickens, 2021; Stelter et al., 2021). The current literature shows that mentorship support programs increase learners' adaptability to the school environment, thereby enhancing academic resilience (Reid-Griffin, 2019; Romney & Grosovsky, 2023). Therefore, it is important to underscore the important role of mentoring as a coping strategy and opportunity for building academic resilience for black female learners enrolled in STEM subjects.

8. Conclusions

This study explored the factors that motivate black female learners to enroll in STEM fields. The findings revealed that learners' intrinsic motivation to persist despite numerous challenges stemmed from their desire to qualify for high-demand fields such as engineering and medicine and build successful careers. Some of the learners further expressed that

they would use the knowledge and skills they gained in STEM to contribute to South Africa's development. Studies have shown that individuals with STEM skills are central to countries' reforms and development agendas (Bayode et al., 2019; Fomunyam, 2019). This is because these individuals tend to be innovative and contribute to addressing complex social, health, and economic problems. However, as reported by Sikhosana et al. (2025) and Sikhosana et al. (2023), these learners, particularly those from needy backgrounds, struggled to thrive in STEM streams due to gender stereotypes and a lack of learning resources. In pursuit of SDGs 4 and 5, appropriate support systems must be put in place to support female learners interested in STEM.

9. Study Limitations and Direction for Future Research

The research was limited to black female learners attending a public secondary school; this is a limitation, as the findings may not be generalizable to other contexts/female learners located elsewhere. However, it is important to note that the researchers' goal was not the generalizability of the findings but to contribute debates about women representation in STEM fields and their resilience.

The research was undertaken during the height of the COVID-19 pandemic in 2022. During this period (2021–2022) educators, learners, and parents were anxious about the future of the education sector, as many schools were forced to pause operations due to their failure to transition to online teaching and learning. It is possible that the learners' experiences, challenges, and the coping strategies they employed were informed by the challenges the pandemic posed to the education sector at the time. It is recommended that researchers replicate this study in diverse contexts to enhance the generalizability of the findings.

Furthermore, the interviews were conducted in English. This is a limitation as the learners' home language was not English. The use of English might have impacted how the learners understood and answered the questions. To counter this challenge, the lead researcher (HS) allowed the learners to respond to questions in their home language (IsiZulu). For future studies, it is recommended that researchers consider translating research tools into languages spoken by locals. This will help enhance the credibility and dependability of research findings and conclusions.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study. Since the sample included underage learners (15–17 years), caregivers were engaged to provide consent for the learners to participate in audio-recorded interviews.

Data Availability Statement: Due to the sensitivity of qualitative data, the researchers would like to work with researchers interested in the data. A reasonable request to access the data can be directed to the lead author.

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Abbreviations

The following abbreviations are used in this manuscript:

STEM	Science, Technology, Engineering, and Mathematics
SADBE	South African Department of Basic Education
GDBE	Gauteng Department of Basic Education
SDGs	Sustainable Development Goals

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