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Gender Differences in Determinants of Students' Interest in STEM Education

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Abstract: Despite the government's call for students to pursue science, technology, engineering, and mathematics in the era of the Fourth Industrial Revolution (4IR), the gender gap in STEM education is still of significant concern in South Africa. This study aimed to describe different push-pull factors that influenced male and female students when choosing STEM education at the TVET college level. This study used qualitative research methods and focus-group interviews with a sample of 20 students studying at a TVET college in a rural part of the Limpopo province. In addition, a thematic analysis was used to analyse the data collected. The study revealed that the following factors: lucrative salary, graduate unemployment rate, aptitude for mathematics and science, parental education and autonomy and independence, and rejecting stereotypical feminine identities were push-pull factors that influenced both male and female TVET college students to choose STEM education. The policy implication of this study is that an Afrocentric approach should be infused into the teaching and learning of STEM at TVET colleges.

Keywords: gender differences; interest; students; STEM education; 4IR

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1. Introduction

South African Government (2012) indicates that the success rate and enrolment of female students at institutions of higher learning, particularly at technical and vocational education and training (TVET) colleges, is lower than that for male students. To address this, the government introduced National Development Plan 2030, emphasizing the need for the government to support students financially to enrol in STEM education, especially at TVET colleges, and this should be realized by 2030. To increase the success rate of the female and male students at the TVET colleges, the government plans to focus on secondary education and ensure that learners in Grade 9, by the end of the year, have mastered the minimum mathematics competencies (Department of Basic Education 2019). National Youth Policy (2020) states that to increase young people's interest in STEM education, the government needs to ensure that young girls are mentored to learn science, technology, engineering, and mathematics with an environmental focus. In addition, the Department of Basic Education should design online teaching that will focus on STEM education; this will increase young people's interest in STEM education.

The post-1994 South African government needs to improve the awareness of STEM education and enrolment of students at Technical and Vocational Education and Training (TVET) colleges. This will help South African youth to gain the necessary skills needed to improve infrastructure development; the country will produce skilled and experienced engineers (Burger 2021). TVET colleges in South Africa are an institution of higher learning that mainly focuses on providing students with practical skills to ensure they are employable in the workforce. TVET colleges in South Africa differ from universities, whereby universities focus more on theory while TVET colleges focus on technical skills that the workforce needs in the 21st century. Therefore, TVET colleges could be viable for many young people in South Africa (Cloete 2021). Since 1994, the South African government has

introduced a TVET policy to ensure that the sector contributes to the country's economic development. However, the sector faces a wide range of challenges, making it hard to reduce unemployment among TVET college graduates (Needham 2019). Makgato (2019) argues that the TVET college sector in South Africa needs to be improved so that it can respond to the skills required for the era of the 4IR.

Marwala (2021) avers that the 4IR era in South Africa should improve people's skills; this requires them to embrace STEM education. Pols (2019) posits that STEM education plays a vital role in preparing people for evolving industries and careers that have never existed before. South Africa is one of the countries in Africa that has achieved a great deal regarding giving girls access to education. Despite this achievement, the evidence shows that female students lag compared to male students in STEM education, particularly at the TVET college. According to UNICEF South Africa (2022), in 2021, more girls studied mathematics and science than boys. However, young boys outperformed girls in both subjects. UNICEF South Africa (2022) further revealed that this indicates a gender gap in higher education and training in South Africa, where it was reported that 28.5 % of female students graduated from STEM-related careers. Marie-Nelly (2021) argues that in Sub-Saharan Africa, women are underrepresented in STEM fields, which will result in women remaining in traditional jobs that new jobs will replace in the future. For decades, South Africa has witnessed young girls experiencing learning difficulties in STEM education at TVET colleges. This has denied millions of young girls access to quality education. However, some African countries, such as Ghana, have made progress in enrolling girls in STEM education. Nevertheless, the ultimate goal is still not being realized, because young women continue to be underrepresented in the STEM industry in contrast with men, who are well-represented in this industry (UNICEF 2021).

The low representation of women in the STEM industry results in gender stereotypes, leading to some women believing STEM education is only meant for males (FSO 2019). In this regard, Koenig and Eagly (2014) confirms that gender gaps exist in mathematics and science education in higher education. The involvement of males in mathematics and science confirms the belief in male superiority where these subjects are concerned and reinforces the belief that these subjects are meant for men. Cultural stereotypes are barriers to students' participation in STEM education (Kayan-Fadlelmula et al. 2022). The South African government needs to design intervention strategies to increase female students' enrolment in STEM education. In addition, the lower number of female students graduating in STEM education continues to increase in South Africa. Additionally, less than 28.5% of female students graduate with careers in STEM education in South Africa, which is a worrying trend (Petersen 2022). It is vital to fill the skills shortage as the Fourth Industrial Revolution gathers pace. However, this will remain a dream for many female students across the globe due to female students remaining a significant minority in STEM education compared to male students (Gender Inequality 2022). Some institutions of higher education have witnessed an increase in the enrolment of female students in mathematics. However, programmes such as chemical engineering have been suffering a leakage of female students (López-Iñesta et al. 2022). According to False Bay TVET College (2021), an absence of women in engineering with sufficient public visibility to act as role models contributes to a gender gap in STEM education in higher education in South Africa. According to Aguilar (2021), lower representation of female students in STEM education can be influenced by a lack of understanding and the self-perception of low content knowledge, making them develop a negative perspective towards STEM education. Male engineering students have higher self-efficacy and lower math anxiety levels compared to female students, which contributes to higher dropout among female students in STEM education (Morán-Soto and González-Peña 2022). Wang and Degol (2016) stress that the lower enrolment of female students in STEM education at TVET college results from lifestyle values or work/family balance preferences, field-specific-ability beliefs, and gender-related stereotypes and biases.

Miller et al. (2018) argue that young people are still aware that more males are in the STEM industries regardless of the representation of women in STEM education and

industries. Therefore, young people grow up believing that a scientist must be a man. This can motivate a boy child to enrol in STEM education, while women can be discouraged from enrolling in STEM education (Hand et al. 2017). Phelps et al. (2018) argue that pre-college academic experiences motivate students to register for STEM education at TVET college. In addition, young people who could score good grades at secondary school find this a great motivation to study STEM-related subjects at TVET college.

According to Kessels and Taconis (2012), students still associate teaching mathematics with gender; therefore, males are the preferred candidates for becoming mathematics teachers. This can be why a boy child is motivated to dream about becoming a mathematics teacher. Therefore, STEM subjects, for example, mathematics, are still regarded as challenging for many young people. However, Mendick (2005) argues that women are motivated to study mathematics because it is intellectually challenging. Parents' education or knowledge of STEM education is pivotal in motivating both male and female students to engage in STEM education at TVET college. Thus, students whose fathers had higher education qualifications are more likely to further their studies in STEM education at TVET college (Dökme et al. 2022).

Labib et al. (2021) state that male and female students choose an engineering major at TVET college because it can improve someone's life and for the positive impact that it has on the community. Various factors motivate both male and female students to enrol in TVET college, particularly in engineering, such as intrinsic motivation, social motivation, financial motivation, and parental motivation (Kolmos et al. 2013). According to Eris et al. (2010), students select engineering at TVET college because the subject has instructional intervention strategies that have a positive impact on self-efficacy. Needham and Papier (2011) argue that young people choose to study engineering at TVET colleges compared to universities because they believe that the practical experience they get at TVET colleges gives them an advantage in the labour market. Both male and female students register to study at TVET college, believing that university qualification does not guarantee employment (Harris 2014). Kaleva et al. (2019) indicate that young people choose to study STEM-related subjects at TVET college because they see the subject as useful in the future compared to other subjects. In addition, males find math more useful in their future than female students.

Self-concept in science, technology, mathematics, and engineering is a mediating factors in pursuing STEM education in the higher education sector among young people (Jeffries et al. 2020). Furthermore, to increase the enrolment of students in STEM education, stakeholders need to come together and design an intervention that will encourage STEM participation for students from varying demographic backgrounds. Thus, social belonging significantly motivates both male and female students to choose STEM education as a career choice (Ito and McPherson 2018).

Few studies have investigated gender differences in students' interest in STEM education with a special focus on rural-based TVET colleges in South Africa; instead, the focus has been on the performance of both males and females in STEM education. Therefore, the present study describes different push-pull factors that influenced male and female students when choosing STEM education at the TVET college level. Thus, rural-based TVET colleges were chosen because most young people do not value rural-based TVET colleges as equally important as urban-based TVET colleges. Therefore, soliciting information from students who are enrolled in rural-based TVET colleges was of great significance in this study. The present study can contribute to the body of knowledge by recommending pedagogical techniques that can be used in the TVET college sector in South Africa to attract young female students to STEM education. Furthermore, it can provide educators in the TVET college in South Africa with all the necessary support to attract young female students to enrol in STEM education in the modern era. In the Fourth Industrial Revolution era, STEM education is at the centre of the future success of both male and female youth. Against this background, there is a need for multifaceted education reforms in the TVET college sector in South Africa to increase both male and female students' interest in STEM

education. The theoretical framework that underpins this study is the push-pull theory. The push-pull theory was developed by Everett Lee in 1966. Push-pull theory emphasizes that certain factors motivate individuals or act to attract people to something (pull factors), and there are others that repel them (push factors). Push factors may include unemployment, health, family background, and economic status. Pull factors may be job opportunities and earning higher salaries. Lee (1966) further states that push factors are external factors that influence individual decision-making skills, while pull factors are desires, which act to attract individuals to decide on life. The application of this theory to the present study is its ability to explain the factors that motivate both male and female students to choose STEM education as a career choice at TVET college. Therefore, I argue that pull factors, which are external factors, play a pivotal role in motivating both male and female young students to choose STEM education at a TVET college. These external factors can include the higher unemployment rate among graduates who do not have qualifications in STEM education. Therefore, to avoid unemployment after graduation, both male and female students decide to choose STEM education, which is known as a form of education that comes with job opportunities. Moreover, I further argue that pull factors can be the reason that motivates both male and female students to choose STEM education at a TVET college. Therefore, the factors could be having the desire to obtain a technical skill in STEM education upon graduation or a student setting up his or her own business. In addition, some students may be influenced or pressured by their families, which is a push factor (external) to choose STEM education at TVET college.

2. Materials and Methods

The qualitative research approach is used in this study. The aim of using a qualitative research approach was to interact with the TVET college students in a social setting to understand their lived experiences better. Several researchers have regarded the qualitative research approach as a valuable method of inquiry in understanding a social problem through the participants' perceptions (Denzin and Lincoln 2011). This method of inquiry allowed the researcher to establish rapport with the participants, and the researcher understood the students' perspectives concerning the push-pull factors regarding pursuing STEM education. The study is descriptive, to develop an in-depth understanding of the topic or subjects.

The study was conducted at one of the rural-based TVET colleges in the Vhembe district in the Limpopo Province. The Vhembe district is in the northern part of the Limpopo Province and shares its eastern and western borders with the Capricorn and Mopani districts. The shared border extends to Zimbabwe in the north, Botswana in the northwest, and Mozambique in the southeast through the Kruger National Park. The district has a land size of 25,597 square kilometres. It has four (4) towns, namely, Makhado, Malamulele, Musina, and Thohoyandou, with a total of 1,402,779 people, "with 416,728 residing in Makhado, 497,237 in Thulamela, 347,974 in Collins Chabane and 32,009 in Musina in 2016. Makhado is the most populated municipality in the district, while Musina LM is the least [populated]" (Vhembe Districts Municipality 2021, 06).

The participants were sampled to obtain a sample size of 20 participants engaged in engineering studies between the ages of 18 and 35 at one TVET college doing NC (V) level four, which is equivalent to final-year majoring in construction engineering. Gender was taken into consideration in this study. Therefore, ten female and ten male TVET college students were sampled. A type of non-probability sampling, purposive sampling, was used to sample the participants who shared the same characteristics, namely, the fact that the participants were all TVET college students in rural areas engaged in STEM education with a particular focus on engineering studies. I decided to select 20 participants because few students were available on campus, and the majority were studying from home. After sampling the participants, I sent the application form to the Campus Manager requesting to interview TVET college students who were enrolled in engineering. Thereafter, the Campus Manager asked the Head of Department of engineering studies to organize students who

were open and interested in participating. Twenty-five participants showed interest; 15 were male students and 10 were female. To balance the genders, the researcher selected ten male and ten female students.

To generate rich data for the study, focus-group discussions (FGDs) interviews were held. The FGDs were conducted with TVET college students engaged in engineering studies to obtain diverse perspectives in a focus-group setting. Two focus-group discussions were held with the students that were separated into two groups of ten students. All the COVID-19 protocols were adhered to, such as wearing face masks and maintaining social distancing. The focus-group interview was conducted in English; however, the participants were allowed to express themselves in Tshivenda and Xitsonga. Data were triangulated by interviewing more than one TVET college student studying engineering to gain multiple perspectives. In addition, theory triangulation was used to enhance data triangulation, whereby the researcher shared the transcripts with a colleague who specialized in skill development to see her interpretations regarding the collected data. The focus-group interviews took between 30 and 40 min and were audio-recorded. The participants were asked about their experience regarding different push-pull factors that influenced them when choosing STEM education at the TVET college level. The following questions (Table 1) were asked to collect information regarding various push-pull factors that influenced them when choosing STEM education at the TVET college level.

Table 1. Focus group interview guide.

Research Questions
• What main economic factors motivated you to pursue STEM education as a career choice at the TVET college level?
• How do you think, in general, the educational background of your parents motivated you to pursue STEM education as a career choice at the TVET college level?
• Tell me how the financial status enjoyed by engineers in the industry influences you to choose this field of study.
• How does rejecting stereotypical feminine identities influence you to choose this field of study?
• How do autonomy and independence influence you to choose this field of study?

The discussions were audio-recorded, transcribed verbatim, and, where participants used Tshivenda and Xitsonga, their views were translated into English. The present study conducted a thematic analysis to make sense of the data generated by the focus-group discussions. Accordingly, all the thematic analysis steps were followed in this study. The first step in this study was becoming familiar with the data. During this step, the researcher read the transcripts several times. This allowed the researcher to become familiar with the body of data collected during the focus-group discussion. In step two, the initial codes were generated to reduce the data elicited during the focus-group discussion process to codes aligned with the predetermined focus-group questions. Step three entailed searching for the themes that emerged during the focus-group discussions that could contribute to the present study. In the process, several interesting themes and sub-themes were identified. During step four, the identified themes/sub-themes were reviewed by going through them several times to check if all these themes made sense in light of the aims and objectives of this study. During step five, the themes/sub-themes were named. This was performed with the purpose of making sure that the themes/sub-themes were well understood. The final step of the thematic analysis involved writing the report based on all the identified themes and sub-themes. The participants validated the data by checking if the presented report reflected their response. To achieve reliability in data analysis, the researcher used the participants' verbatim quotes, and the manuscript was presented to the participants to ensure that data presented did not misrepresent the participant's views. Secondly an expert researcher in gender studies was consulted to check that the researcher did not misinterpret the participant's views.

From the start, the researcher assured the participants that any information shared in the present study would be treated with respect, remain confidential, and only be used for the present study. The validity of the study's findings was achieved through data triangulation. In addition, the study findings were presented to the participants to confirm whether the study findings reflected their views. All the participants confirmed that their views were not misrepresented in the study findings. To achieve reliability in the present study, the manuscript with the recorded audio was also sent to two researchers to check if the coded dataset in the manuscript represented the participant's views.

For ethical purposes, the proposal was sent to the institutional review boards or research committee of the University of South Africa for approval, following which ethical clearance was granted. Ethical clearance number 2022/05/11/90501543/10/AM was obtained from the Research Ethics Committee of the College of Education at the University of South Africa. Once the university had approved the study procedures, the researcher went to the selected TVET colleges and the campus manager was asked for permission to interview the participants after explaining the purpose of the study to him. In addition, the purpose of the study was explained to the participants. Participants were also asked to sign an informed consent form before the focus-group interviews were conducted. Furthermore, the anonymity of the students was maintained. The participants were assured that any information provided in the present study would be regarded as strictly confidential. The recorded audio would not be shared with anyone and would be used solely for the present study. The demographic characteristics of the participants are presented in (Table 2) below.

Table 2. Demographic characteristics.

Demographic Characteristics	Frequency
Gender	
Female	10
Male	10
Age	
18–24 Years	15
25–35 Years	5
Language	
Xitsonga	16
Tshivenda	4

3. Results

The results were based on the accounts of the experiences and comments of the TVET college students and were guided by one study objective, which was to describe different push-pull factors that influenced both male and female students when choosing STEM education at the TVET college level. The following sub-themes that emerged in the study were discussed: lucrative salary, graduate unemployment rate, aptitude for mathematics and science, parental education, and autonomy and independence.

3.1. Theme 1: Economic Factors That Influenced Students to Choose This Field of Study

A number of push-pull factors influence students to pursue their career in STEM-related fields at the TVET college level, and economic factors are one of these factors. In this regard, the participants confirmed that the higher unemployment rate among graduates from other fields of studies had influenced their decision to choose STEM education at the TVET college to avoid being unemployed upon graduation. On the other hand, it was indicated during the focus-group interview that STEM education is considered a profitable career as a result of professionals in the STEM industry earning a good salary, which influenced students' decision to pursue a career in STEM education at the TVET college level. Sub-themes emerged in this theme are described next.

3.1.1. Sub-Theme 1: Lucrative Salary

The participants were asked about the economic factors that motivated them to pursue STEM education at the TVET college. Money was advanced as a reason for choosing STEM education because the participants believed people in the STEM industry earn good salaries. In addition, most of the responses from male and female participants during the interviews indicated that people in the STEM industry are making more money than those other industries in South Africa. For that reason, the participants believed that by choosing STEM education, they would be able to make more money than in other professions upon completion of their studies.

> "I have read on social media platforms how much engineers are making in South Africa. Once I become an engineer, I will make more money, like these guys". (Male participant)

> "I think this field of study will help me to make more money upon my completion because I can see that engineers are making money in the industry". (Female participant)

The above responses of the participants in the focus-group interviews indicate that financial freedom correlated strongly with choosing STEM education as a career for both males and females in the TVET college.

> "Engineering on its own is a qualification that provides you with a technical skill to help you start your own business. I think this qualification will provide me with the skills I need to start a construction business in the near future". (Female participant)

Youth entrepreneurship is vital for economic growth and job creation in South Africa. According to the above female participant, an engineering qualification would be a stepping stone for her to pursue a career in the construction business since the qualification would equip her with the requisite technical skills to run a construction business.

3.1.2. Sub-Theme 2: Graduate Unemployment Rates

The South African government has been battling the scourge of youth unemployment. The worst part is that even young graduates are forced to resort to begging on the streets for jobs. Undoubtedly, the mismatch between qualifications and what the market needs are a matter of discussion for youth and education policymakers in South Africa. An economic factor that has influenced female and male students to pursue a career in STEM education at the TVET college is the problem of youth unemployment among graduates, as highlighted by the participants. This is evident in the following statements of the participants:

> "My brother completed his qualification in both the humanities and the social sciences, six years ago, and up till today, he hasn't had a job in the field in which he studied, not even an internship. So, I had to choose a career that had something to do with mathematics and science because the field has more job opportunities than other fields, so I think I will not struggle to find employment after completing this qualification". (Female participant)

> "In this era, you can't just choose any qualification for the sake of studying. One needs to choose a qualification that will help you find a job after studying. I chose this qualification because I believe I will get a good job after studying. I won't sit at home and have nothing to do". (Male participant)

The above statements imply that TVET college students, both males and females, chose an engineering qualification believing that after completing their qualifications they would not struggle to find employment, because the field has many job opportunities. It is important for students, both males and females, to choose a field that is in demand on the market.

3.2. Theme 2: Pull Factors That Influenced Students to Choose This Field of Study

Pull factors were found to be an important motivator for male and female students to pursue STEM education at the rural TVET college in South Africa. These pull factors include autonomy, independence, and rejecting stereotypical feminine identities, which are crucial in helping a young person to make informed choices.

Sub-Theme 1: Autonomy, Independence, and Rejecting Stereotypical Feminine Identities

The focus-group interview responses revealed that autonomy and independence influenced TVET college students in choosing STEM education as their career choice. The female participants shared that autonomy and independence were among the pull factors that motivated them to study towards a STEM qualification in contrast with the male participants. In addition, the female participants believed that studying toward a STEM qualification would play a crucial role in enabling them to attain independence, as this qualification offered various opportunities for women to become financially and emotionally independent. Some of the participants relayed their opinions as follows:

> "Studying engineering will make me financially and emotionally independent because this qualification will empower me to think outside the box". (female participant)

> "We grew up being told science and engineering are meant for males and not females. So, I did well in mathematics and science in secondary school and decided to study something related to mathematics at a TVET college, so I can also show other females it is possible". (female participant)

The above extracts from the participants reveal that they rejected stereotypical feminine identities that discourage female students from enrolling in STEM courses because they were told that these subjects were meant for male students. This reason was among the motivating factors influencing female students to study engineering in higher education institutions.

The male participants expressed different views about autonomy and independence and rejected the notion that stereotypical feminine identities were one of the motivating factors for why men chose engineering. For them, the choice had nothing to do with gender but the passion and drive to study engineering so they could become engineers in the near future. This is illustrated by the responses below:

> "For me, it was a personal choice to choose engineering; it was not about the belief that this field is meant for men and not women. I pay little attention to these things; men and women are the same, with the same ability. Often females do better in mathematics and science in high school than us males". (Male participant)

> "I do not believe that my gender had something to do with my choosing engineering or trying to be independent. It is just because I love this field". (Male participant)

The quotations above indicate that male students, in contrast with female students, did not believe their gender played a role in their decision to choose engineering as a field of study. Instead, it was the passion that motivated them. Interestingly, this shows that South Africa is on the right path to achieving gender equality. This is underscored by the fact that male students acknowledged that some female students performed much better than male students in mathematics and science.

3.3. Theme 3: Level of Education

Parents' level of education plays a vital role in influencing their children's career choices. The knowledge that parents have about a certain subject enable them to have influence in their children's career development. The following sub-themes merged with this theme.

3.3.1. Sub-Theme 1: Parental Education

Parents' knowledge about careers in the STEM industry plays a pivotal role in influencing TVET college students to choose a career that involves studying STEM subjects. When the participants were asked about their parents' educational background's influence on their career choices, the researcher received mixed reactions under this sub-theme. A few participants indicated that having parents who had received a tertiary education helped them consider choosing engineering as a field of study. Some participants had the following to say regarding their parents' education:

> "My father is a teacher; he teaches mathematics at high school. He always advised me to study something related to mathematics so that it will be easy for me to get a job after completing my studies".
>
> (Female participant)
>
> "My mother always tells me, no matter what, I must study something related to science because it will open important doors for me". (Female participant)

In contrast with the above views, some participants during the focus-group interviews indicated that choosing engineering as a field of study had not been influenced by their parents' education level. In fact, some participants came from families where no one had ever had formal education. Therefore, choosing a STEM subject meant they owned their choices, particularly among male TVET college students.

3.3.2. Sub-Theme 2: Aptitude for Mathematics and Science

For male and female students, being exceptionally good in mathematics and science at secondary schools also presented opportunities for students to study engineering in higher education institutions. Having an aptitude for mathematics and science at a young age plays a definitive role in students' career choices regardless of gender, resulting in them choosing a career in STEM where they could make a meaningful contribution to the STEM field. The extracts shown below reveal the participants' views on academic performance as one of the push-pull factors that influenced them to pursue STEM education:

> "I always knew that when I go to university or college, I will study something related to mathematics and science because I always performed well in these subjects; I can say I am passionate and love mathematics. It helps me to think logically". (Male participant)
>
> "I did not perform well in other subjects, but I always performed very well in mathematics. This influenced me to enrol in engineering. I wanted to go to university, but sadly I didn't perform well in my other subject, so I didn't have enough marks to be accepted, although I did very well in mathematics. I hope after completing my diploma here, I will be able to enrol at a university to obtain my degree in one of the STEM fields. This field of study is challenging and helps make one a critical thinker". (Female participant)

The above extracts from the participants show that the love of mathematics and science, and a passion for getting high marks in secondary schools, emerged as the driving factors that led to both male and female students pursuing engineering studies. It is important to note that the goal of education in the 21st century should be to produce critical thinkers. It is clear from the participants' responses that they chose this field of study because it is challenging and makes them critical thinkers, which is of paramount importance in modern society.

4. Discussion

This study aimed to describe different push-pull factors that influenced male and female students when choosing STEM education at the TVET college level. The findings provided important insights into the factors that influenced TVET college students when choosing STEM education at the TVET college to prepare them for their future careers.

Based on the shared views of the TVET college students in the rural part of the Limpopo Province, similar responses from both male and female college students were received regarding what had influenced them to choose STEM education to prepare them for their future careers. There is evidence that economic factors were influential push-pull factors for male and female TVET college students when choosing STEM education. Labib et al. (2021) indicate that students choose maths and science at TVET colleges since the qualification is financially rewarding. This study revealed that the higher remuneration that people in the STEM industry received was a significant motivating factor for male and female TVET college students in deciding to pursue a course in STEM education. Students in the modern era are more concerned about choosing a career that would allow them to earn sufficient money (Mcglynn 2007). This shows that TVET college students believed that, upon completion of their studies, they would make a good salary that would help them to live a good life, in contrast with students who did not pursue STEM education.

The results from the study further revealed that female TVET college students had decided to engage in STEM education to attain technical and creative skills that would create a way for them to start their own business in construction. The study by Li et al. (2019) reveals that the factor that motivates students to pursue STEM education regardless of their gender is that it provides students with the critical skills needed in the 21st century. Significantly, the findings showed that in the era of women's empowerment, young people no longer go to schools to be employed after graduation but to be job creators through entrepreneurship. This reality calls for a new way of teaching and learning in higher education where both male and female students can be taught to be entrepreneurs or think in the manner of entrepreneurs by being problem solvers in their fields. Peri et al.'s (2015) study shows that people who possess STEM qualifications play a pivotal role in driving economic growth.

Interestingly, Wang et al. (2013) aver that students with good verbal skills are more likely to choose STEM education. In addition, female students are more likely to have better verbal skills than male students. Youth unemployment among graduates, particularly those who had not studied STEM subjects, was regarded as one of the factors that created fear. This fear influenced both male and female TVET college students relating to STEM education in their career choice. Curiosity in learning mathematics is considered one of the factors that stimulates both male and female students' interest in pursuing mathematics as a career choice at an institution of higher learning (Fuqoha et al. 2018). In addition to choosing STEM education at a TVET college level, it was seen by both male and female students as a valuable and good choice that would open doors for them to participate in the labour market by being employed in a reputable company. This finding concurs with Shippe (2021), who indicates that both male and female students should choose STEM education because STEM offers more job opportunities than non-STEM fields.

The study results also reflected how being good in mathematics and science in secondary schools influenced male and female TVET college students to choose STEM subjects as part of their career choices. Similar to Phelps et al. (2018), secondary education and good grades motivate students to register for STEM education at a TVET college. The quality of the teacher–student relationship at the secondary high school is central to both male and female students' motivation and sustained engagement with science at the institutions of higher learning (Wood 2019). Thus, both male and female TVET college students who participated in the present study revealed that doing well in mathematics and science compared to other subjects was the indicator that influenced their decision to pursue STEM education. This finding is consistent with that of Simon et al. (2014), who argues that students who do well in mathematics and science in high schools are more likely to choose a STEM career. Emotional intelligence, self-esteem, and self-efficacy are significant factors that motivate both male and female students to pursue a career in STEM education (Ugwuanyi et al. 2020). According to Ochieng et al. (2020), female students choose STEM education at TVET college due to their intellectual ability. In South Africa, most students who received lower grades in secondary school (matric) decided to go to a TVET college to

further their education. Accordingly, the averages of their high school or matric marks play a role in influencing students' decision to study science (Rocca 2013). Another important finding from the study, regarding what the female TVET college students shared, was having parents who were knowledgeable about mathematics and science. This played a crucial role in their choice of STEM education, unlike the male students who revealed that their decision had not been influenced by their parents' education or knowledge of STEM education. Rojas (2021) avers that for students who come from families where the parents have majored in STEM education, there is a better chance of these students choosing a career in STEM, regardless of their gender. According to Tandrayen-Ragoobur and Gokulsing (2021), female students are more likely than to male students to choose STEM education at higher education if family members and schoolteachers support them.

Wang and Degol's (2013) study shows that female students are likely to pursue STEM careers because of gender barriers that male students do not face. Female students revealed that since STEM education is a male-dominated field, they felt they had to choose this field of study to change the status quo and the gender stereotypes associated with STEM education. In contrast, the male students in the present study indicated that gender had not influenced their decision to pursue a career in STEM; instead, their decision was influenced by their passion for STEM. Wang and Degol (2016) reveal that, particularly concerning female students, gender-related stereotypes and biases have influenced students' motivation to pursue STEM education. The push-pull factors theory supports the study's findings. The push factors that motivated both male and female students to choose STEM education as a career choice are economic factors, such as graduate unemployment rates. In addition to this, this push factor motivated both male and female students to pursue a career in STEM-related education with the hope that upon their graduation they will not be unemployed. The pull factor that motivated both male and female students to pursue a career in STEM education include being independent and challenging the gender stereotype, particularly among female TVET college students.

This study has several limitations. Firstly, the data were collected from a small sample size of 20 participants. Therefore, the study findings cannot be generalized to the entire population of students pursuing a STEM education at the TVET college level in South Africa. Secondly, the study only targeted TVET college students from rural areas. Thus, a longitudinal study may be required to explore whether males and female students are influenced by different push-pull factors when choosing a STEM education in preparation for their future careers in STEM at TVET colleges in South Africa, including those in urban areas. Furthermore, the results of this study could be beneficial for STEM education experts and stakeholders. In addition, career expos must be promoted using these push-pull factors to encourage young people to further their STEM education at TVET colleges. One of the strengths of the current study is its qualitative inquiry to understand different push-pull factors that motivated both male and female students to pursue careers in STEM education at TVET college.

5. Conclusions

Evidence has emerged regarding the push-pull factors that influenced students in rural-based TVET colleges to choose STEM subjects, with a specific focus on engineering students. It has become clear that push-pull factors, such as parental education and the lucrative salary enjoyed by personnel in the STEM industry, motivated both male and female TVET college student to choose STEM education as their career. Their parents' education was found to have an influence on the student choice of STEM education as a career, which is a push factor (external), along with autonomy and independence, which is a pull factor (internal). Besides this, the other significant factor was male and female student aptitude for mathematics and science. The study thus affirmed the factors that influenced both male and female students' decision to enrol in STEM education at the TVET college level. Through the study findings, it is hoped that policymakers can benefit from the views presented herein. The push-pull factors that motivated students to pursue

a career in STEM education emerging from the study have the potential to motivate both male and female students to pursue a career in STEM education at TVET colleges.

6. Recommendations

The policy implication of this study in education practice is that an Afrocentric approach should be infused into the teaching and learning of STEM education at TVET colleges. The government should have a policy that encourages all government departments to provide bursaries for young women who want to engage in STEM education. Role models, particularly women pursuing careers in the STEM field, should be invited to secondary schools to motivate learners about the opportunities available in STEM education. Furthermore, the South African government should ensure that STEM education and careers are a national priority, if the country intends to compete on the global stage. In addition, non-governmental youth organizations that present mathematics and science literacy classes after school should be supported by the government, because these programs can impart the skills students need to do well in STEM education.

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Informed Consent Statement: Permission to conduct the study was obtained from the TVET college campus manger and verbal consent was obtained from the participants before the initial interview.

Data Availability Statement: Interview transcriptions are available at reasonable request.

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