Bridging the Gender Gap: Strategies for Enhancing Girls' Participation in STEM-Related TVET Programmes in Cape Coast Metropolis in Ghana

Christina Boateng[1]

[1]christina.boateng@ucc.edu.gh

[1]https://orcid.org/0000-0002-5934-1489

[1]University of Cape Coast, Cape Coast, Ghana

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ABSTRACT

This study investigates the persistent underrepresentation of girls in Science, Technology, Engineering Mathematics (STEM) -related Technical and Vocational Education and Training (TVET) programmes at the pre-tertiary level in the Cape Coast Metropolis. Recognizing the critical role of STEM careers in driving socio-economic development, the study identifies the factors contributing to this gender disparity and proposes strategies to enhance female participation in STEM –related TVET programmes. The study is informed by the Social Role Theory. The convergent mixed-method research approach and the cross-sectional research design were employed. Uutilising the census sampling, 109 girls enrolled in STEM- related TVET programmes in pre-tertiary TVET delivery institutions in the Metropolis were selected for the study. Primary data as well as secondary data as collected from the Institutions and utilised. The primary data was collected using a structured questionnaire and interviews. Data analysis was done using descriptive statistics. The findings revealed that despite ongoing efforts to promote gender equality, significant barriers continue to hinder girls' enrolment in STEM-related TVET programmes. These barriers include systemic challenges, entrenched societal stereotypes, insufficient institutional support, and absence of targeted interventions. The study concludes that a multi-faceted approach, involving a comprehensive action and strong support is needed at the school level to address the issue. It is therefore recommended that school leaders should employ strategies to counteract the persistent stereotypes, encourage support, and inspire more girls to pursue STEM-related TVET. These should include instituting mentorship programmes to connect female students with successful women in STEM-related TVET fields as role models to provide guidance, share personal experiences, and encourage female students to explore and participate in the field. Again, community awareness campaigns aimed at changing the perceptions of parents, guardians as well as the broader community about STEM field and professions for girls should be launched to promote the relevance and benefits of STEM –related TVET education for girls and society as a whole.

Keywords: Female Participation, STEM-Related TVET, TVET Programmes, Technical Education, Vocational Education, STEM Careers

I. INTRODUCTION

Technical and Vocational Education and Training (TVET) is the type of education that provides individuals with the knowledge, skills, qualifications and competencies necessary to participate productively in the labour market. According to the United Nations Educational, Scientific, and Cultural Organization's International Centre for Technical and Vocational Education and Training (UNESCO - UNEVOC, 2016), TVET is valued for its ability to improve individuals' quality of life by equipping them with practical skills that enhance economic productivity, foster independence, and contribute to reducing poverty and social marginalization. In its strategy for TVET for 2016 – 2021, UNESCO - UNEVOC underscored the vital role of TVET in equipping people with skills for decent work and economic growth, as stated in Sustainable Development Goal 8, and the task of preparing individuals to respond effectively to the dynamic labour market needs. In recent years, there has been an increasing integration of Science, Technology, Engineering, and Mathematics (STEM) into TVET curriculum as a key strategy for improving innovation and productivity. This is because, in today's job market, STEM skills are in high demand due to their role in fostering technological advancement and sustainable growth (Tikly et al., 2020).

Underrepresentation of girls in Science, Technology, Engineering, and Mathematics (STEM) fields is a global concern, with particular challenges in TVET disciplines. According to the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2017), only 35% of students enrolled in STEM-related fields of study worldwide are

women, with the gap widening in TVET-focused STEM disciplines. This issue is echoed across sub-Saharan Africa where the enrolment of girls into STEM-related TVET programmes remains disproportionately low. In a study conducted by Dzisi and Asare (2022), presented at the Pan-Commonwealth Forum, the findings highlighted that despite efforts to increase female participation in STEM-TVET, significant gender disparities persist across the sub-region.

In Ghana, the trend is no different. The Ghanaian government has made notable efforts to improve the appeal and accessibility of TVET programmes. Initiatives such as the Ghana TVET Voucher Project, which subsidizes costs for students, the modernization of vocational institutions through improved infrastructure aim to attract more young learners, including girls, and policies promoting STEM education at the basic and secondary school levels have been implemented to increase early exposure to STEM fields (Ministry of Education, 2020). However, these initiatives have yielded mixed results, as significant barriers still persist. Girls' enrolment into pre-tertiary STEM-TVET programmes still lags far behind those of boys (Adams et al., 2019).

Research has shown that girls face numerous challenges globally in STEM disciplines. These challenges range from discriminatory social norms, lack of access to quality STEM resources, cultural biases, gender stereotypes, lack of female role models, etc. (UNESCO, 2017). In sub-Saharan Africa, the issue is further compounded by broader systemic challenges, including poverty, inadequate teacher training, and resource allocation practices that often favour male-dominated industries and subjects (World Bank, 2020a). In 2022, the MasterCard Foundation also identified cultural perceptions, limited role models, and domestic pressures as barriers to girls' participation in STEM fields and called for targeted interventions to rectify the situation. This stems from the fact that without a deliberate and sustained effort to close the gender gap in STEM-related TVET programmes, attaining some of the development goals, particularly those that align with Sustainable Development Goal 4 on inclusive and equitable quality education will remain out of reach for many developing countries. Achieving gender equity in STEM education is therefore not only a moral imperative but also a strategic investment in a country's future. The reason is that by empowering girls to participate fully in STEM-related TVET, nations can unlock the untapped potential of their female population, diversify their workforce, and drive sustainable economic development (UNESCO, 2017). Understanding the factors influencing girls' participation in STEM-related TVET programmes is therefore vital. Such insights can guide efforts to design policies and interventions that will promote gender parity and ensure equitable opportunities for all learners; thereby enhancing the ability for a nation to achieve its development goals and encourage economic growth.

1.1 Statement of the Problem

Ghana recognizes the importance and value of TVET and has introduced several policies and initiatives to increase access and improve the quality of this form of education to meet the demands of its growing and evolving economy. Several policies and initiatives have been implemented in recent years to make TVET programmes more appealing, increase access and improve its quality in the country. Despite these initiatives to promote gender equity in TVET education, the participation of girls in STEM-related TVET disciplines in Ghana remains critically low. According to the Ghana Statistical Service, girls account for less than 20% of students enrolled in STEM TVET programmes. Meanwhile, the youth unemployment rate in Ghana has historically been higher for females than for males, reflecting broader gender inequalities in access to quality employment, skills training, and economic opportunities (United Nations Population Fund [UNPF], 2021). While more males are employed in technical fields and vocational training, females are often found in more traditional and lower-paying roles such as in the services sector. This trend is a concern because it presents as a missed opportunity for national development. Diversifying the workforce by encouraging female participation in STEM-related skills contributes to fostering innovation, addressing challenges within society, and propelling economic growth in this increasingly technology-driven world (World Bank, 2020 b).

Sociocultural barriers are among the most significant factors contributing to the low participation of girls in STEM-related TVET programmes. Gender stereotypes, deeply rooted in cultural norms, often portray STEM fields as male-dominated, discouraging girls from pursuing their interests in Science, Technology, Engineering, and Mathematics (Akoto & Donkor, 2019). Parents and communities frequently reinforce these stereotypes by steering girls toward traditional career paths such as sewing, cooking, nursing, administrative roles, etc., that are perceived as more feminine (Amoako et al., 2020). These societal expectations create significant psychological and motivational barriers for girls, making it difficult for them to envisage themselves doing well in STEM-related careers and jobs.

Institutional barriers also play a substantial role in discouraging girls from enrolling in STEM-related TVET programmes. Many TVET institutions in Ghana suffer from inadequate funding, leading to poorly equipped laboratories, outdated tools, and limited access to modern technology (Suleiman et al., 2021). These inadequacies affect the quality of training provided and diminish students' confidence in the relevance of their career choices. Furthermore, the lack of well-trained female instructors with expertise in STEM subjects hampers effective teaching and learning and affects girls, who may already face additional challenges in these traditionally male-dominated spaces. Another critical challenge is the lack of female role models and mentors in STEM fields, particularly within TVET programmes. There is often a lack of visible examples of women who have successfully navigated STEM-related careers, and who can serve

as sources of inspiration and guidance for the younger generation (Boateng & Owusu, 2020). Beyond sociocultural and institutional barriers, there are challenges relating to industry exposure. Research has shown that girls who enrol in STEM-related TVET programmes often struggle to transition to higher education or employment due to insufficient guidance and practical training opportunities (Ampofo et al., 2022).

The issue of low participation of girls in STEM-related TVET programmes extends beyond enrolment numbers. It also presents a stumbling block toward the attainment of inclusive and equitable education (UNESCO, 2017). It further diminishes the full realization of a nation's potential by tapping into all available talents for its sustainable development. By excluding a significant portion of the population from fully participating in STEM-related industries, Ghana risks missing critical opportunities to enhance its workforce, drive innovation, and achieve inclusive economic growth. This would have significant implications for the development agenda as it limits the nation's ability to fully utilise its human capital to achieve Sustainable Development Goals (SDGs), particularly SDG 4 on Quality Education SDG 5 on Gender Equality and SDG 8 on Decent Work and Economic Development (McGrath et el. 2018).

There must therefore be conscious and sustained efforts to bridge the gender gap in the intake and retention of STEM-related programmes and disciplines; otherwise, it will continue to widen, ultimately affecting national efforts to build a skilled and inclusive workforce, and hampering long-term socioeconomic development. Thus, a closer examination of the factors contributing to gender disparities in TVET programmes to understand the barriers girls face in STEM-related TVET at the pre-tertiary level will therefore be essential in understanding the issues so that comprehensive and effective policies and interventions could be formulated to ensure that Ghana can improve gender equality in TVET careers and promote greater women participation in its workforce for effective and efficient productivity.

1.2 Research Objectives

Specifically, the study objectives were to

(i) Analyse the current status of girls' participation in STEM-related TVET disciplines
(ii) Identify the factors influencing their participation
(iii) Examine the challenges they encounter
(iv) Explore existing initiatives aimed at promoting gender inclusivity in STEM-related TVET
(v) Propose evidence-based strategies for increasing girls' participation and success in STEM-related TVET programmes.

II. LITERATURE REVIEW

2.1 Theoretical Review

The Social Role Theory is a social psychological theory developed by Alice Eagly in 1987. The theory suggest that gender differences are not inherent but rather stem from the social expectations associated with each gender. Eagly explains that gender differences in behaviour, attitudes, and expectations based on the roles that society assigns to men and women.

The key elements of this theory are that as people grew -up they would internalise the social roles and societal expectations and this will shape their self-concept of who they are and how they behave. Another element is the issue of gender stereotypes. This is the perception that men and women performing different tasks in the society. For example, women are stereotyped as more caring and nurturing and are therefore expected to play that role in the society while men, who are seen in leadership roles, are perceived to be more assertive and dominant. By reinforcement of this socialisation, parents, families, communities and even institutions such as schools and workplaces recognises, encourages and rewards those who conform to societal expectations.

This theory can be used to explain the issue of gender disparities in STEM -related TVET. In many societies, traditionally, careers such as engineering, construction, and automotive technology have been associated with men, and others such as fashion, cosmetology, nursing, cooking, have been perceived as more appropriate for women (Amoako et al., 2020). Due to historical divisions of labour and deep-seated gender stereo-typical thinking, when women enrol in STEM-related TVET courses, they often face discrimination and bias in job placements and career advancement. But by challenging these outdated norms, we can create a world where both men and women feel equally welcome in technical and vocational careers. Studies have shown that gender stereotypes influence career aspirations from young age, and interventions such as mentorship, scholarships, and awareness campaigns can help break these patterns (Eagly & Wood, 2012).

2.2 Empirical Review

2.2.1 State of Girls' Enrolment in STEM-related TVET

The underrepresentation of girls in STEM-related Technical and Vocational Education and Training (TVET) programmes is a pressing issue across the globe. Despite advancements in education, the gender gap in STEM-related TVET persists, driven by a combination of societal, cultural, economic, and institutional barriers. Nandi et al. (2023) in a study that analysed female enrolment trends in STEM education in India, found out that while enrolment is gradually increasing, it remains lower compared to that of males, particularly in engineering and technology fields. Ergün (2019) also highlighted that while female students had high STEM awareness, varying levels of engagement persisted across different grade levels. Again, in 2016, UNESCO reported a global trend of male students outnumbering female students in TVET programmes despite efforts to promote gender parity. This disparity was attributed to multiple factors, including biases in curriculum and teaching methods, as well as insufficient support for female students' self-esteem and aspirations (Bataineh et al., 2022).

Gender disparity in TVET programmes in Ghana remains a significant issue that affects women's educational outcomes and their ability to secure employment in the formal labour market. Although TVET is essential for economic development, there is a noticeable underrepresentation of women in TVET fields, particularly in careers that require knowledge of science, technology, engineering, and mathematics (STEM) disciplines (Boakye, 2019). Despite efforts by the government to increase access to TVET, gender inequalities persist, with women more likely to enrol in courses that are traditionally associated with lower pay and lower status. That is, their access to TVET is often limited by gender stereotypes that steer them towards traditionally "female" courses, such as catering, fashion, and hairdressing, rather than fields like engineering, technology, or construction (Boakye, 2019). This pattern reflects deeper societal beliefs that certain vocational roles are more suited to women, while others are seen as appropriate for men (Mensah & Torgbor, 2017). The unequal participation again has profound implications for women's economic empowerment and social mobility. Women are often underrepresented in higher-paying male-dominated occupations; which perpetuate the gender wage gap and limit their opportunities for career advancement (Antwi & Aidoo, 2020).

2.2.2 Factors Influencing Girls' Enrolment in STEM-Related TVET

The literature abounds with evidence that several factors have influence on the participation of girls in STEM-related TVET. Takyi-Bondzie et al. (2022) investigated factors affecting STEM integration in Ghana's educational curriculum. The study identified structural factors that impact girls' enrolment in STEM-related TVET and highlighted the need for well-qualified STEM teachers and continuous professional development as essential for effective STEM education.

Similarly, Baffour-Awuah and Thompson (2012) focused on the reforms in Technical and Vocational Skills Development (TVSD) in Ghana, examining the role of the Council for Technical and Vocational Education and Training (COTVET). Their analysis underscored the challenges of aligning TVET with industry needs and emphasised sustainable funding and government commitment, offering foundational insights into the structural factors influencing girls' enrolment in TVET programs.

Attitudes, aspirations, and perceptions have also been found to further shape girls' enrolment in STEM-related TVET. Ibrahim and Şeker (2022) explored middle school students' attitudes towards STEM education in Turkey and Ghana and found out that students had positive attitudes and variations were based on school location rather than gender. This study provides a general view of students' perceptions that can influence enrolment trends. Wrigley-Asante et al. (2022) investigated career aspirations among STEM students in Ghana, revealing that while gender differences in career aspirations were not significant, economic considerations and external encouragement played distinct roles. Although this study does not directly address TVET, it highlights motivational factors affecting enrolment. Quansah et al. (2020) also analysed determinants influencing female senior high school students' choices of STEM programs in Ghana, identifying significant school-related, home-related, and personal factors. Their detailed findings provide valuable insights into the factors influencing girls' enrolment in STEM-related TVET. Hu and Stahl (2023) used narrative inquiry to explore female STEM students' identities and learning trajectories, offering a deep understanding of how personal experiences and societal factors shape female students' educational paths. Their qualitative approach illuminates the complex dynamics affecting enrolment and persistence in STEM careers. That study emphasises the importance of addressing these factors to improve female participation in TVET.

2.2.3 Challenges Faced by Girls in STEM-Related TVET

Understanding the barriers that girls face in STEM-related TVET at the pre-tertiary level is essential to promoting gender inclusivity in our workforce. Existing literature suggests that the gender imbalance in STEM-related TVET programmes is multifaceted, rooted in a complex mix of cultural, social, and institutional barriers (Ritz & Fan, 2015). Societal norms and traditional gender roles often discourage women from pursuing technical and engineering courses, instead directing them toward perceived "feminine" career fields such as fashion, catering, and cosmetology

(Mensah & Torgbor, 2017). Akon-Yamga et al. (2024) exploring the issues in STEM teaching and learning in Ghana, identified inadequate resources and gender-biased curriculum as major obstacles. The stigmatization of TVET programmes and the associated challenges are also emphasized by Essel et al. (2014), who noted that stigma and systemic issues such as deficiencies in career guidance and counselling services in senior high schools in Ghana, hinder the participation of females in STEM-related TVET. Similarly, Sadia et al. (2020) conducted a systematic review that identified various barriers including low self-efficacy, lack of role models, and family influence as major barriers to girls' participation in STEM and stressed the importance of addressing both internal and external factors. Pathak (2022) reviewed literature on female participation in STEM, highlighting stereotypes, societal biases, and lack of confidence as major barriers. Steffen et al. (2023) investigated how critical incidents impact female students' attitudes towards STEM subjects, revealing that negative experiences can affect perceptions, while positive experiences can foster interest and confidence. Again, Merayo and Ayuso (2023) found that girls face barriers such as lower self-esteem and less encouragement from families and teachers, suggesting that targeted interventions are necessary to address these specific obstacles. Knopke and León de la Barra (2022) focused on motivational factors affecting female students' engagement in Technology Education and found that engaging students in meaningful projects and providing freedom of choice enhances motivation. This suggests that while awareness is growing, motivational strategies need to be tailored to address these engagement challenges. All these studies collectively emphasize the need for supportive policies and interventions to overcome systemic and societal challenges.

Another pointer in the literature is that in different geographical contexts, specific barriers to female participation in TVET are identified. Bhatta (2017) studied gender equality in Nepal, noting high female participation in traditional trades but low engagement in non-traditional ones, emphasizing the need for awareness programmes. Najoli (2019) evaluated the Women in Technical Education and Development (WITED) programme in Kenya, highlighting challenges such as cultural stereotypes and lack of role models. Paudel (2019) investigated barriers in Nepal, revealing challenges related to education, labour market conditions, and social norms, and advocating for increased investment and gender-transformative approaches. Jamaludin et al. (2023) discussed strengthening TVET in Malaysia by improving curriculum, facilities, and management. These underscore the need to understand the challenges in specific locales in order to institute tailor-made solutions to the problem.

2.2.4 Strategies to Improve Girls' Participation in STEM-related TVET

Addressing the challenges faced by girls in STEM-related TVET involves implementing targeted strategies that can enhance their engagement and success. These strategies can be categorized into several key areas:

Kijima et al. (2021) assessed the impact of a design thinking workshop on female youths' perceptions of STEM in Japan. Their findings suggest that innovative interventions like design thinking can effectively enhance girls' engagement with STEM by improving their creative confidence and interest. Similarly, Arhin (2009) emphasized the need for improved career counselling and breaking down stereotypes to increase female students' interest in technical education. These studies highlight the importance of innovative and supportive educational interventions to boost girls' participation in STEM-related TVET. Nandi et al. (2023) recommended measures to increase female enrolment in STEM by addressing constraints and creating supportive environments. This is complemented by Nurhaeni and Kurniawan (2018), who assessed gender mainstreaming in vocational high schools in Indonesia and found that effective gender mainstreaming requires comprehensive implementation of all components. Both studies emphasize the importance of creating environments that support and encourage female participation. Hite and Spott (2022) evaluated the impact of a STEM outreach programme on parents' and teachers' perceptions, suggesting that more sustained engagement and resources are needed to shift perceptions and promote girls' STEM interests. Luo et al. (2022) found that supportive social agents, such as parental support and mentorship, are crucial for encouraging female students to pursue STEM degrees. These studies underscore the role of parental and community involvement in enhancing girls' STEM participation.

Wrigley-Asante et al. (2022) and (2023) recommended formal and informal mentorship programmes and internships, noting that role models and encouragement significantly impact female students' career aspirations. Yabas et al. (2022) demonstrated that targeted projects like educational robotics, involving all-girl teams, increased interest in STEM and improved STEM identity and problem-solving skills. These findings highlight the effectiveness of mentorship and role models in fostering girls' STEM engagement.

He et al. (2020) identified curriculum influences, teacher attitudes, and parental expectations as key factors affecting female students' choice of STEM programme. The study suggests that targeted interventions addressing these factors could improve participation. Merayo and Ayuso (2023) advocated for promoting STEM activities, increasing self-confidence, and implementing gender-sensitive curricula, while Ortiz-Martínez et al. (2023) explored educational innovations like mentoring and digital platforms to support women in STEM. These studies suggest that curriculum improvements and innovative educational practices are vital for enhancing female participation in STEM. Additionally, Siregar et al. (2023) found that parental education levels positively influence STEM interest, suggesting that policies

addressing these factors could improve girls' participation. These studies provide strategies for tackling gender-specific barriers to STEM participation. Amri (2014) examined strategies for aligning TVET with emerging careers in life sciences, emphasizing the need for relevant curriculum and hands-on activities.

III. METHODOLOGY

3.1 Research Design

The research design that was utilized for this study is the converging parallel mixed-methods cross-sectional design. This design is used when a researcher combines qualitative and quantitative data to provide an all-encompassing analysis of the research problem. The design was highly beneficial for the study because the quantitative data offered statistical insights into enrolment status while the qualitative data allowed the researcher to explore the underlying challenges and strategies in girls' participation. The primary justification for collecting data using a combination of methodologies in this study was to ensure completeness, in the sense that a more complete picture will be produced as a result of this action. It is believed that inherent biases in any one method can be eliminated through the utilization of a mixed-method approach (Creswell, 2003; Davis, 2003; Ivankova et al., 2006). In addition, the mixed method design makes it possible to utilize triangulation as a data collection strategy to answer the research questions. In the process of triangulation, two or more approaches to data collection are utilized concurrently within the same period, making the results more credible (Bryman, 2015).

3.2 Study Area

Cape Coast Metropolis is considered a historic hub located along the coastal belt of Ghana in West Africa. It is the capital of the Central Region of Ghana and is considered by many as the citadel of education in Ghana. The Metropolis can boast of three prominent senior high technical schools: Cape Coast Technical Institute, Efutu Senior High Technical School and Oguaa Senior High Technical School. Cape Coast Technical School is a well-established institution dedicated to providing vocational and technical education, offers a comprehensive curriculum in TVET and train students with the necessary competencies to thrive in various technical fields. Efutu SHTS and Oguaa SHTS on the other hand, provide diverse academic programmes in addition to TVET programmes. Combining academic rigour with practical training, they prepare students for success in both higher education and the workforce. Together these schools play a vital role in nurturing a skilled workforce capable of contributing to the industrial and technological development of the country.

3.3 Population, Sample and Sampling Procedure

The population for the study were all girls enrolled and studying TVET-related courses in the selected schools in the Metropolis as well as TVET teachers, Heads of Departments and School Administrators. For the quantitative phase of the study, census sampling was chosen to allow for the inclusion of every member of the target population, ensuring a comprehensive and precise representation of the study group, as outlined by Hester et al., 2020. The approach provides the most reliable results by capturing detailed data from the entire population. This resulted in a sample size of 109 respondents.

For the qualitative phase of the study, purposive sampling was employed to select school administrators, heads of departments, teachers and students. This method involves deliberately choosing individuals based on the researcher's judgment of their relevance and expertise in the subject matter (Archer, 2023; Taherdoost, 2018). The choice of a sample size for this part of the study was therefore 26 participants; influenced by the principle of depth of analysis, and data saturation. Data saturation occurred when no new themes or insights emerged from additional interviews, indicating that a comprehensive understanding of the research topic under discussion had been reached. This approach ensured a thorough understanding of the perspectives of key stakeholders involved in the study.

3.4 Data Collection Instrument

Data for this study were collected using two primary instruments: questionnaires and interview guides. The questionnaire was selected for its efficiency and cost-effectiveness, allowing for the collection of data from a large number of respondents quickly. The questionnaire utilized a four-point Likert scale, ranging from 1 ("Strongly Disagree") to 4 ("Strongly Agree"), and featured closed-ended questions, which offered fixed response options. The instrument was pre-tested at a school with similar characteristics to those in the study area and target population. The pretesting aimed to ensure that the questionnaire effectively measured what it intended and assessed its comprehensiveness. The Cronbach's alpha method was used to determine the reliability coefficient using SPSS version 23. The resulting reliability score was 0.679, surpassing the acceptable threshold of 0.6, thus confirming the questionnaires' reliability according to Zamanzadeh et al. 2008. To ensure the validity of the instruments, content validity was confirmed by having other research experts review the items. This process ensured that the questions were

clear and comprehensive, allowing for the collection of relevant data to meet the study's purpose and objectives (Mohamad et al., 2015).

3.5 Data Collection and Analysis

Steps were taken to ensure that all involved parties were informed about the study and their consent was sought before the start of data collection. This process included explaining the research purpose, the nature of the study, and the rights of the participants. Participants were asked to voluntarily agree to participate and sign consent forms. A face-to-face meeting was then scheduled for the 109 female students from the three schools to administer the questionnaire. For the qualitative phase, a structured interview guide was used to seek the perspective of participants on the influential factors, challenges and strategies in place to promote gender parity in their schools as well as what could be done to enhance girls' participation. The interviews offered valuable information that complemented the questionnaire data and provided a comprehensive understanding of the research topic. Interviews were held at locations that were convenient for the participants: teachers preferred the staff common room, heads of departments chose their offices, and headmasters were interviewed in their offices. All interviews were recorded for accuracy and later transcribed.

Quantitative data were coded and analysed using SPSS Version 23. The interpretation was done with line graphs tracking enrolment trends and mean and standard deviation calculations identifying factors affecting enrolment decisions.

Challenges encountered by female students were explored both quantitatively (mean and standard deviation) and qualitatively (thematic analysis), providing an understanding of the barriers faced. Thematic analysis was also used to identify strategies to make STEM-TVET programmes more attractive to female students.

In addition to the primary data collected, secondary data on admission records from the three schools from 2020 to 2024 into the three schools was requested for. This was done to track the enrolment figures for each year.

IV. FINDINGS & DISCUSSION

4.1 State of Girls' Enrolment in Stem-related TVET Programmes

The first objective sought to investigate the current state of girls' enrolment in STEM-related TVET in TVET. To answer this objective, the enrolment figures of girls into various STEM-related TVET programmes over five years were collected from school management. The data was analysed using descriptive statistics and presented using the line chart as seen in Figure 1.

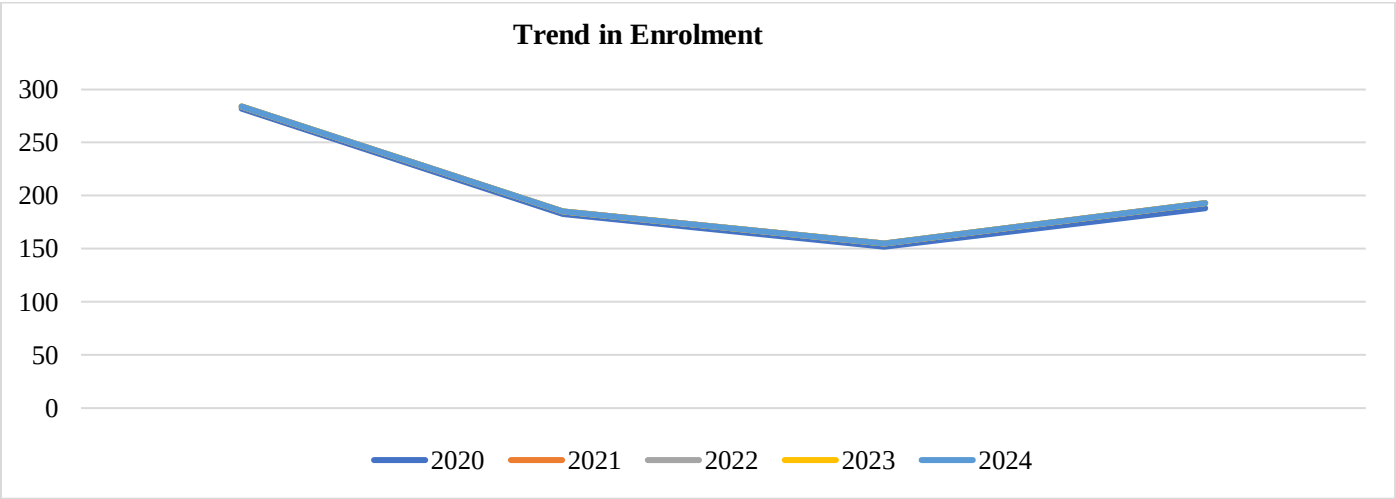

Figure 1

Enrolments in Girls in STEM-related TVET between 2020 and 2024

Figure 1 above reveals a consistent decline in female enrolment in STEM-related TVET programmes over the last five years. As shown in the figure, enrolment decreased from 282 female students in 2020 to 183 in 2021, further declining to 152 in 2022, then increased to 188 in 2023, then declined again and reached 109 in 2024. This downward trend was observed despite the several initiatives that the government had put in place to encourage the participation of girls in TVET in general and STEM-related TVET in particular.

4.2 Factors Influencing Female Students' Enrolment in Stem-Related TVET Programmes

The study also sought to understand the factors that had influenced their decision to enrol in STEM-related TVET programmes. The responses are presented in Table 1.

Table 1

Factors Influencing Female Students' Enrolment in Stem-Related TVET Programmes

Statement	Mean	Std. Dev.
Overall influenced.	3.0826	0.89369
Female students have equal opportunities for enrolment in technical and senior high technical schools compared to male students.	2.5321	1.19852
The enrolment process in technical and senior high technical schools is biased towards male students.	3.3028	0.91797
Female students receive adequate support and encouragement from school authorities to enrol in technical and senior high technical schools.	2.4037	1.17157
There are sufficient resources and facilities in technical and senior high technical schools to support the enrolment and participation of female students.	3.4862	0.88835
Female students face societal pressure or stereotypes that discourage them from enrolling in technical and senior high technical schools.	2.4220	1.17295
Female students are actively encouraged to pursue STEM-related subjects in technical and senior high technical schools.	2.2752	0.94155
Female students receive adequate mentorship and guidance to help them succeed in technical and senior high technical school programs	3.1927	0.85502
The curriculum and teaching methods in technical and senior high technical schools are inclusive and supportive of female students' learning needs.	2.1743	1.04389
Female students feel empowered and confident to pursue careers in technical fields after graduating from technical and senior high technical schools.	2.1927	1.05827

N=109

Curriculum inclusivity received the lowest score, 2.17 (SD = 1.04), indicating significant concerns about whether the curriculum adequately meets female students' needs. Additionally, students rated their confidence in pursuing technical careers at a low 2.19 (SD = 1.06), implying that many feel underprepared for future roles in these fields. The lack of proactive encouragement for girls in STEM is reflected in a low score of 2.28 (SD = 0.94). The results further suggest that societal pressures and stereotypes, with a mean of 2.42 (SD = 1.17), continue to discourage female enrolment.

Meanwhile, opportunities for mentorship and guidance as well as sufficient facilities and resources for teaching and learning, however, were viewed somewhat positively, scoring 3.19 (SD = 0.86), and 3.48(SD= 0.89) respectively.

In summary, while resources and facilities are seen as sufficient, there are critical gaps in equal opportunities, support, encouragement, and curriculum inclusivity. Addressing these areas could enhance female students' experiences in STEM-TVET programmes.

4.3 Challenges Girls Face in Enrolling on STEM-related TVET Programmes.

To gain a better understanding and more insight into the challenges girls face in enrolling in STEM-related TVET, the study examined the challenges girls encounter as they opt to participate in STEM-related TVET programmes. The result was presented as challenges from the macro-level perspective and challenges from the micro-level. Table 2 presents challenges from the |macro level perspective

Table 2

Challenges Female Students Face Enrolling in STEM-related TVET Programmes

Statement	Mean	Std. Dev.
Cost-sharing in education	3.2752	0.83745
Lack of clear goals and adequate monitoring of gender equality.	3.6422	3.91938
Poor provision of infrastructural facilities such as libraries, classroom blocks, workshops, laboratories, and recreational facilities.	2.7156	1.29165
Lack of consumable materials such as wood nails, wires, rods, glues, etc. for students' practical work.	2.2202	1.26460
Lack of qualified and competent TVET tutors and instructors	2.7339	1.17570
Poor funding of technical education.	1.6330	0.95898
Lack of scholarship scheme for female TVET students	3.1835	0.99224
Gender-biased TVET curriculum materials	3.0642	1.10784

N=109

The result highlights several significant barriers impacting the participation and success of girls from the macro system level. Lack of clear goals and adequate monitoring of gender equality showed a high mean score of 3.64 (SD = 3.91). This reflects systemic barriers and inadequate policy support for ensuring gender equity in STEM-related TVET programmes. Cost-sharing in education also emerged as a notable challenge with a mean score of 3.27 (SD = 0.84). Lack of infrastructural facilities, such as libraries, classrooms, and workshops, was indicated by a mean score of 2.71 (SD = 1.29. This highlights the insufficient resources available to support practical learning in technical subjects. Similarly, the lack of provision for consumable materials for practical work, with a mean score of 2.22(SD = 1.26), further aggravates the challenges students face in hands-on training. Poor funding of technical education received the lowest mean score of 1.63 (SD = 0.95) underscoring a significant issue with inadequate financial support for TVET programmes. The availability of qualified technical education lecturers also poses a problem, with a mean of 2.73 (SD = 1.17), indicating that a shortage of qualified educators impacts the quality of education. Poor funding of TVET received the lowest mean score of 1.63 (SD = 0.96), underscoring a significant issue with inadequate financial support for TVET programmes.

The result above suggests that the financial burden of education is a significant concern for female students, affecting their ability to enrol and continue in TVET programmes. It also reveals a significant gap in governmental support, especially in the provision of practical materials, tools, and policies designed to encourage girls' participation in STEM-related TVET.

Table 3 presents the various school-related challenges (Micro level) that female students encounter in participating in STEM-related TVET programmes.

Table 3

Challenges Female Students face in STEM-related TVET programmes at the Institutional Level

Statement	Mean	Std. Dev.
Inadequate female TVET lecturers	2.5321	1.25143
Lack of changing room	2.7890	1.00989
Inflexible selection and entry requirements	3.2294	.89890
Absence of female role models	3.3486	.78618
Masculine image of TVET projected in textbooks, media, and popular assumptions	3.1284	.88298
Poor TVET facilities	2.8073	1.02268
Poor public relations practice by administrators and lecturers of the technical education department	2.9541	1.05747
Inappropriate assumptions made by male TVET lecturers	3.1468	.83694

N=109

The results revealed several obstacles that significantly impact female students' participation and success in STEM-related TVET at the institutional level. Inadequate female TVET lecturers received a mean score of 2.53 (SD = 1.25) indicating a notable concern about the lack of female educators in TVET programmes. This scarcity can contribute to a less supportive learning environment for female students. The lack of essential facilities such as changing rooms (mean = 2.78, SD = 1.01) mean = 2.83, SD = 1.10) further impedes female students' ability to fully participate in and benefit from the programmes. These deficiencies highlight the need for improved infrastructure to support female students. Inflexible selection and entry requirements scored a mean of 3.22(SD = 0.89), reflecting challenges related to the accessibility of TVET programs. This inflexibility can serve as a barrier to entry for female students.

The absence of female role models (mean = 3.34, SD = 0.78) and the masculine image of TVET projected in textbooks, media, and popular assumptions (mean = 3.13 SD = 0.88) worsen gender disparities. These factors contribute to a less welcoming environment for female students and reinforce stereotypes that may discourage their participation. Challenges related to poor TVET facilities (mean = 2.80, SD = 1.02) and inappropriate assumptions made by male TVET lecturers (mean = 3.14, SD = 0.83) further highlight systemic issues within the educational setting. These problems can affect the quality of education and the overall experience for female students.

Finally, poor public relations practices by administrators and lecturers (mean = 2.95, SD = 1.05) contribute to a potentially unwelcoming atmosphere for female students, further hindering their educational experience. The above findings point to several barriers within the schools, including inadequate practical facilities, limited access to medical services, and a shortage of female teachers, all of which limit girls' participation in STEM-TVET programmes. This aligns with Nandi et al. (2023), who stress the need for supportive educational environments to boost female enrolment in STEM fields. Additionally, the shortage of female role models in schools, highlighted in the data, reflects a common challenge discussed in the literature. Wrigley-Asante et al. (2022) emphasize the value of both formal and informal mentorship programs to inspire and encourage girls to pursue STEM pathways.

4.4 Existing Interventions to Encourage Girls' Participation in STEM-Related TVET Programmes

The study also explored the existing initiatives that are in place to encourage the participation and retention of girls in STEM-related TVET programmes. It was found that while some initiatives have been introduced to increase girls' participation in STEM-related TVET programmes, their effectiveness has been limited due to erratic implementation and lack of extensive coverage. Key informants had indicated for example that a mentorship programme had been introduced from the office of the Council for Technical and Vocational Education and Training (CTVET), the national body responsible for TVET Policy formulation and implementation in the country. However, only selected schools or individuals got to participate. In most cases, there were no follow-ups after the initial introduction. Beyond that, there were no modalities in place for individual schools to scale up such programmes on their own. As such the little gain made by the project made a limited overall impact.

Similarly, community awareness campaigns have been run mainly at the national level, aimed at changing societal perceptions about girls in STEM-related TVET fields. However, the effect of such a programme remains minimal without sustained efforts and broader outreach. Due to lack of funding, the organization of such programmes at the local level has been sporadic, the study revealed.

In one of the institutions, it was shared that they rely on their Alumni to offer mentorship. A Head of Department had this to say.

> *"I always encourage female alumni to return and mentor current students. Female alumni returning to mentor current students provide relatable role models and boost their interest in the programmes they are offering."*

The finding here underscores the issue of inadequate support, particularly in providing the needed conducive atmosphere, practical materials and tools, as well as policies and scholarships tailored to girls. This resonates with the literature, such as the study by Jamaludin et al. (2023), which emphasizes the need for improved curriculum, facilities, and government support to strengthen TVET programmes

4.5 How to Enhance Girls' Participation in STEM-related TVET Programmes

The study also sought to find out how girls' participation in STEM-related TVET could be enhanced. Key informants shared their views as to what can be done. The participants alluded to the fact that they needed better resources.

Teacher 1 said:

> "*We currently lack adequate* Science kits and lab equipment. *We are not able to do practicals and students do not get excited about what they are* learning. *To improve girls' participation, schools need better learning resources.*

Another teacher said:

> *"Increasing the availability of textbooks and learning materials specific to STEM fields is crucial. Girls need access to up-to-date resources to feel confident in their studies."*

Headmaster 2:

> *"We need to advocate for better funding and support from the government and private sector to ensure that schools have the necessary resources to support STEM education for girls."*

Student 1:

> *"We don't have enough practical materials in our science labs, which makes learning less interesting and harder for us girls."*

Student 2:

> *"Access to modern technology and resources would help us understand STEM subjects better and make learning more exciting."*

The need for a safe and supportive environment for girls was identified.

Teacher 3 had this to say:

> *"Creating a safe and supportive environment is essential. Girls should feel that they are welcome and valued in our classes without fear of discrimination or harassment."*

Head of Department 3*:*

> *"We need to promote respect and equality within the classroom. There should be no room for teasing or ridicule. Girls must feel safe and comfortable in class.*

Headmaster 3:

"We have implemented policies to create a more inclusive environment, but continuous efforts are needed to address any form of bias and ensure that girls are encouraged to participate."

Student 3:

"Sometimes, there are negative attitudes towards girls in STEM classes. It would help if teachers and classmates were more supportive and encouraging."

Student 16

"*A more inclusive and friendly environment in classes would make it easier for us to participate and feel confident.*

Head of the institution*:*

"We need to promote respect and equality within the classroom; ensuring a supportive learning environment means we must train our teachers to recognize and address gender bias."

The use of mentorship programmes and role models to encourage and inspire young girls was also identified.

Headmaster 1 said:

"*Role models and mentorship are crucial. We should work on establishing these connections to provide ongoing support and inspiration for girls."*

Teacher 12:

"Having successful females in STEM fields can inspire girls. We should invite women professionals to speak and mentor students more often."

Teacher 2:

"Mentorship programmes, where girls can interact with women who have succeeded in STEM careers, could provide valuable guidance and encouragement."

Head of Department 1:

"*We should establish partnerships with organizations that can provide mentors for female students. This could help bridge the gap between education and real-world STEM careers."*

Head of Department 2:

"*Encouraging female alumni to return and mentor current students could provide relatable role models and boost their interest in STEM."*

Community engagement was found to be a valuable strategy to enhance the participation of girls in STEM-related TVET.

Teacher 21:

"We can engage *the community through programmes, take the opportunity to highlight the importance of STEM careers for girls to help shift perceptions and encourage more support from families."*

Head of Department 1:

"Engaging the community through workshops and events can raise awareness about the value of STEM education for girls and promote broader support."

Headmaster 2:

"Community leaders should be involved in advocating for girls' participation in STEM. Careers. Their support can be instrumental in changing local attitudes and encouraging enrolment."

Student 7:

"If the community actively supported girls in STEM, it would make a big difference. More community events and awareness programs could help."

Teacher 2*:*

"Educating parents about the benefits of STEM education and encouraging their support can influence girls' participation. Parental involvement is key to a student's success."

Head of Department 2:

"Schools should offer workshops for parents to understand the importance of STEM education and how they can support their daughters who select careers in STEM.

Headmaster 1:

"Parental support is crucial. We need to create programmes that engage parents and provide them with the knowledge and resources to support their daughters' STEM education."

There was also use of extracurricular clubs and activities to attract more girls and sustain their interest in STEM-related TVET.

Headmaster 2*:*

"Clubs and activities outside the regular curriculum can play a significant role in engaging girls in STEM. We should ensure these programs are accessible and well-promoted in our schools.

Teacher 3:

"Extracurricular clubs focused on STEM subjects can provide additional support and interest. Schools should create and promote these clubs to encourage girls to participate."

Head of Department 3:

"Organizing STEM-related competitions and events can spark interest among girls and offer them opportunities to showcase their skills."

Headmaster 2*:*

"Clubs and activities outside the regular curriculum can play a significant role in engaging girls in STEM. We should ensure these programs are accessible and well-promoted."

Headmaster 3:

"Creating more opportunities for girls to engage in STEM through after-school programmes and competitions can help sustain their interest and involvement because here the girl learn through fun activities and that can help keep their interest."

Student 5:

"Joining STEM clubs and participating in competitions has been a great way for me to learn and stay motivated."

Student 6:

"I think having more STEM-related activities and clubs would make STEM subjects more fun and engaging for us."

From the narration above, better resources, a safe and supportive environment, mentorship programmes and role models, community engagement, and the use of extracurricular clubs and activities were identified as strategies that can enhance enrolment and retention of girls in STEM-related TVET programmes in the schools. With these strategies, schools and their immediate communities can create a more inclusive and supportive environment for girls to participate in STEM -related TVET programmes, thereby improving their success rates and reducing the gender disparity gap.

V. CONCLUSIONS & RECOMMENDATIONS

5.1 Conclusions

Based on the above findings, it can be concluded that despite various initiatives introduced in the country, gender inequality in STEM-related TVET persists. Systemic, institutional, societal and cultural norms continue to play a significant role in discouraging girls from enrolling on STEM-related TVET programmes, thus, suggesting that existing strategies are insufficient and are not properly being executed. The study concludes that without a deliberate institutional action and strong support, efforts to increase female participation in STEM-related TVET will remain a mirage.

5.2 Recommendations

It is therefore recommended that schools and school authorities take the lead role in developing tailor-made policies and support to address the specific challenges faced by girls in STEM-related. They must establish gender equity policies and offer support services at the school level, offer mentorship programmes to connect female students with successful women in –related careers to provide guidance and encouragement. Additionally, the schools must set up community engagement programmes are crucial for promoting gender equality in STEM through awareness campaigns that challenge stereotypes. Additionally, increased funding is needed to enhance STEM education infrastructure, including modern laboratories and learning materials.

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