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Parental Influence, Career Counselling, and Role Models in Girls' STEM Career Choices: Evidence from Three Public Universities in Ghana

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ABSTRACT

Girls' participation in STEM careers remains low despite global efforts to close the gender gap. This study examines the factors influencing girls' pursuit of STEM-related careers in three public universities in Ghana, focusing on parental educational attainment, parental involvement, career counselling, and exposure to role models. Using the Social Cognitive Career Theory (SCCT) as a framework, the study explores how personal, contextual, and social influences shape career decisions. A mixed-methods approach was employed, collecting quantitative data from 424 female tertiary students and qualitative insights from 15 semi-structured interviews. Findings indicate that parental involvement, career counselling, and role models significantly impact girls' STEM career choices, explaining 38%, 41%, and 49.8% of the variance, respectively. However, parental educational attainment did not significantly influence STEM career selection. The study highlights the critical role of mentorship, career guidance, and family support in shaping STEM aspirations. It recommends policy measures to strengthen career counselling, increase access to STEM role models, and enhance parental engagement in career discussions.

Keywords: parental involvement, STEM career choices, career counselling, role models, girls in STEM in three public universities in Ghana

INTRODUCTION

As society evolves and technology advances, the demand for professionals who understand these technologies and can propose practical solutions grows (Muniz, 2023). Mathematics forms the foundation of science, technology, and engineering, enabling people to identify patterns, test relationships, draw conclusions, and model the real world (Velarde, 2019). Sulai and Sulai (2020) argue that mathematics education has been a crucial agent of sustainable development and self-reliance. Science, Technology, Engineering, and Mathematics (STEM) is an integrated programme that combines these four disciplines, encouraging students to use cross-disciplinary knowledge to solve problems (Importance of STEM Education in Nigeria Educational System, 2021). STEM education has gained significant attention for its role in fostering critical thinking, problem-solving skills, and preparing students for future challenges (English, 2023; Fitzmaurice et al., 2021). In an increasingly complex world, effective communication and collaboration are vital for STEM students (Importance of STEM Education in Nigeria Educational System, 2021).

Research has shown that in Ghana, significantly fewer women than men are studying STEM subjects at the university level (Quarshie et al., 2023). This gender gap in STEM education leads to fewer skilled women

contributing to the country's scientific and technological development, which is crucial for Ghana's economic and social progress (Armah, 2022). Parental involvement, including their educational attainment, plays a critical role in shaping girls' academic and career decisions (Howard et al., 2023). Additionally, research suggests that awareness of STEM career opportunities and understanding of their importance for future economic development is often influenced by parental background and education (Amegah et al., 2023). A lack of female role models and gender stereotypes within families and communities can further limit the extent to which girls perceive themselves as fitting into STEM careers (Chavatzia, 2017; Ferati et al., 2023; González-Pérez et al., 2020).

In Ghana, the push to increase female participation in STEM is aligned with national goals such as the Ghana STEM Education Policy and the Ghana Education Strategic Plan (2018–2030), which emphasise equity and science-based learning for national development. Despite these policies, enrolment statistics reveal a persistent gender gap at the tertiary level, particularly in technical and engineering fields (Quarshie et al., 2023). Public universities like University of Education, Winneba (UEW), University of Cape Coast (UCC), and Kwame University of Science and Technology (KNUST) have initiated STEM outreach and inclusion strategies, yet systemic challenges—like limited access to female mentors and career guidance—still affect girls' STEM pathways. This study contributes to evaluating these efforts and informing further improvement. Numerous international and local studies confirm that parental involvement, career counselling, and role models influence girls' career choices, particularly in STEM fields (Lloyd et al., 2018; Gülhan, 2023; Guenaga et al., 2022). However, these studies often focus on secondary-level students or are conducted outside of Ghana, such as in Australia, Spain, or the USA. In Ghana, the literature is limited in capturing how these factors influence girls at the tertiary level, particularly in the context of three distinct public universities. Therefore, this study fills a crucial gap by examining how these influences operate among Ghanaian female STEM students at the university level, offering context-specific insights that can inform local educational policy and practice.

LITERATURE REVIEW

Introduction

The underrepresentation of women in science, technology, engineering, and mathematics (STEM) remains a global concern, shaped by a complex interplay of social, cultural, institutional, and personal factors. Understanding these influences is critical to designing effective interventions that promote inclusive participation in STEM education and careers. While this study is situated within the Ghanaian context, it is equally important to reflect on how other countries have addressed similar challenges and to draw lessons from international literature and policy efforts. Globally, successful strategies for increasing girls' participation in STEM often include early exposure, curriculum reform, strong career guidance, and robust mentoring systems (UNESCO, 2017; OECD, 2019). For example, Finland and Australia have incorporated female scientists into classroom experiences and policy planning to enhance visibility and relevance. These models underscore the need for context-specific adaptations. Ghana, in particular, can benefit from such approaches by integrating female mentorship, structured career counselling, and stronger school-industry partnerships to address local cultural and systemic barriers.

This literature review explores empirical and theoretical studies on the role of parental educational attainment, parental involvement, career counselling, mentorship, and exposure to role models in shaping girls' STEM career aspirations. It also examines the persistent barriers girls face in pursuing STEM pathways, situates these within Ghana's policy and institutional frameworks, and applies the Social Cognitive Career Theory (SCCT) to interpret career decision-making processes. The review further includes reflections on global STEM policy practices to draw relevant lessons for Ghana. Ultimately, this synthesis of literature provides the foundation for the current study by identifying critical gaps, particularly the lack of institution-specific, university-level evidence on the factors influencing Ghanaian girls' pursuit of STEM careers.

Empirical framework

Parental educational attainment and girls' decision to pursue STEM-related careers at the tertiary levels

Research shows that parental educational attainment significantly influences children's career aspirations, particularly in STEM fields. Higher levels of parental education often led to greater academic expectations, increased support, and improved access to resources that encourage STEM engagement (Luo et al., 2022). Davis-Kean et al. (2021) found that students with more educated parents were more inclined to express interest in STEM careers, as these parents can provide educational resources and guide decision-making. Similarly, Werang et al. (2024) highlighted the link between parental education and socioeconomic status, demonstrating that higher parental educational achievement boosts children's academic performance and confidence in pursuing STEM careers. Families with educated parents are more likely to encourage STEM-related activities, creating a positive

environment for career exploration (Plasman et al., 2023; Svoboda et al., 2016). The study indicated that daughters of highly educated parents often receive encouragement to engage in STEM, suggesting that parents with advanced degrees are more likely to value education and support their children's pursuits in these fields.

Parental involvement and girls' decisions to pursue STEM-related careers at the tertiary level

While the educational attainment of parents provides one form of influence, recent studies suggest that parental involvement—through emotional, academic, and instrumental support—plays a more substantial role in shaping girls' interest and persistence in STEM fields. Parental involvement refers to the various ways parents engage in their children's education, including providing emotional support, learning resources, monitoring academic progress, and participating in school activities (Siani et al., 2020). In STEM education, such involvement has a profound effect. Gülhan (2023) identified three key forms of involvement: academic support (e.g., tutoring or supervision), career socialisation (e.g., discussing job options), and instrumental support (e.g., purchasing books or science kits). These practices shape self-efficacy and interest in STEM among girls, often compensating for lack of role models in school.

Lloyd et al. (2018) studied the impact of parental involvement on children's aspirations toward STEM careers using a mixed-methods approach. Their study, conducted among 6,492 middle and high school students from New South Wales, Australia, ensured a diverse representation across socioeconomic, gender, and ethnic backgrounds. Findings showed that parental encouragement substantially enhanced children's interest in STEM careers, with qualitative insights suggesting that science-related activities at home fostered a deeper STEM interest. Thus, parental engagement emerged as pivotal in shaping STEM career aspirations.

Gülhan's (2023) systematic literature review on parental involvement in STEM education examined 24 international studies, largely from the USA. Focusing mainly on primary students, this review utilised PRISMA criteria, covering studies conducted from 2014 to 2022, with an uptick in research around 2021. The methodologies ranged from surveys (41.66%) to case studies and experiments, addressing themes such as family participation in STEM programmes, family history's role in STEM learning, and home-based STEM activities. Gülhan concluded that parental involvement significantly impacts children's STEM success, especially through interactive, technology-supported activities.

Similarly, Gomez-Arizaga et al. (2020) investigated parental and school influences on the academic decisions of highly able (HA) students in Chile, emphasising gender disparities in STEM. Through focus groups with 61 secondary school students identified via Raven's Progressive Matrices, the study found that parental influence, particularly from fathers, was a significant driver in career interest. However, some parents unintentionally reinforced gender-specific barriers, especially affecting female students. Although teachers were motivational figures, they often prioritised skill-building over fostering genuine engagement in STEM, and school activities did not always resonate with students' true interests.

In Nigeria, Sanni et al. (2024) explored the role of parental involvement in undergraduate STEM students' career choices, using a concurrent mixed methods design with 150 students and five parents from two states. The study revealed that while parental involvement and support notably guided students toward STEM careers, the students still perceived freedom in their choices. Consistent parental support, guidance, and encouragement significantly increased the likelihood of STEM career selection, particularly when parents themselves had STEM backgrounds. The study highlighted parents as critical influences on career decisions, suggesting that their support and encouragement can shape students' career trajectories in STEM (Plasman et al., 2023; Tilbrook and Shifrer, 2021).

Career Counselling, Career Workshops, and Mentorship

Beyond the influence of parents, institutional and interpersonal supports such as career counselling, career workshops, and mentorship also play a crucial role in shaping girls' STEM career trajectories. Career counselling plays a vital role in shaping students' awareness, aspirations, and decisions related to career pathways, especially in STEM (Argyro, 2019). It encompasses structured guidance provided by trained personnel through individual or group sessions. Career workshops, often facilitated by schools or NGOs, introduce students to practical skills, educational pathways, and career options. Research shows that effective counselling and workshops significantly boost girls' confidence and interest in STEM careers when delivered early and consistently (Murcia et al., 2020). Mentorship involves ongoing, supportive relationships where experienced individuals (mentors) guide less experienced ones (mentees) through career and academic challenges. In STEM, mentorship—especially by female professionals—has been shown to demystify the field, counter stereotypes, and increase retention of girls in science and technology fields (Guenaga et al., 2022; Cheryan et al., 2015).

Argyro (2019) conducted a meta-analysis to investigate the impact of career counselling intervention programmes on middle school students' STEM engagement. The study focused on the under-representation of

women, disadvantaged youths, and ethnic minorities in STEM fields. The meta-analysis revealed that school counselling techniques and activities positively influenced students' STEM self-efficacy, outcome expectations, intentions, and career-related goals. The study concluded that early interventions at the middle school level are crucial for broadening career development processes and increasing the flow of students into the STEM pipeline.

Murcia et al. (2020) used social cognitive career theory (SCCT) in a qualitative study to explore factors influencing youth STEM career choices. The research involved 15 students, their parents, and three career counsellors from three faith-based schools in Western Australia. Schools were purposefully selected for their active and highly regarded career counsellors, and students identified based on their interest in STEM. The study identified four major themes: the influence of parents' career experiences and students' learning achievements on STEM career choices, diverse sources of STEM career information, and the high value placed on STEM careers by both parents and students. The study emphasised the significant role of career advisors in informing students about STEM careers and the substantial impact of parents on their children's career choices.

Exposure to STEM role models and girls' decisions regarding STEM careers

Visibility of role models is an important social influence on girls' career choices. Female professionals who have succeeded in science and technology serve not only as inspiration but also as tangible proof that such paths are attainable. Exposure to female role models in STEM is a significant predictor of girls' motivation and interest in pursuing similar careers. Role models help girls visualise themselves in positions of success, thereby reducing self-doubt and stereotype threat (Diekman et al., 2010). González-Pérez et al. (2020) found that girls who interacted with female scientists were more likely to express confidence in STEM disciplines. The visibility of women in technical roles validates girls' aspirations and creates a sense of belonging, especially in male-dominated fields like engineering and computer science.

Exposure to female role models in STEM is a significant predictor of girls' motivation and interest in pursuing similar careers. Role models help girls visualise themselves in positions of success, thereby reducing self-doubt and stereotype threat (Diekman et al., 2010). González-Pérez et al. (2020) found that girls who interacted with female scientists were more likely to express confidence in STEM disciplines. The visibility of women in technical roles validates girls' aspirations and creates a sense of belonging, especially in male-dominated fields like engineering and computer science.

Guenaga et al. (2022) investigated how female role models in group mentoring sessions influence young girls' attitudes toward STEM. In a pre-test/post-test experimental design, they focused on 303 students aged 10 to 12 from various Spanish schools, selected via convenience sampling. Findings revealed a positive shift in students' attitudes toward technology and increased awareness of female STEM professionals, especially among girls. However, while the programme boosted girls' interest in STEM, it did not significantly change gendered stereotypes in mathematical self-efficacy, with girls still showing lower confidence in math than boys. The study concluded that female role models positively impact girls' STEM aspirations, though broader measures are needed to combat stereotypes around mathematical abilities.

Diekman et al. (2010) examined the use of female role models and Gender Equitable Teaching Strategies (GETS) to enhance young women's STEM interest. Through an action research approach, they involved 20 female high school students in elective STEM-CTE courses and conducted a focus group with 12 others in a large suburban high school in the Midwest. STEM identity surveys administered before and after the course revealed improved attitudes toward STEM and an increased enrolment of female students in advanced STEM courses the following year. The study concluded that female role models and gender-equitable teaching significantly boost young women's STEM engagement.

Barriers Affecting Girls in STEM

In addition to the supportive factors previously discussed, girls pursuing STEM careers also face numerous barriers that limit their engagement and success in these fields. Research identifies multiple barriers affecting girls in STEM, including negative classroom experiences, gender-biased teaching practices, stereotype threat, and lack of female role models (Chavatzia, 2017; Ferati et al., 2023). Cultural expectations around femininity and science, as well as limited access to mentoring and career guidance, contribute to lower enrolment and persistence in STEM fields. Moreover, girls often receive less encouragement from teachers and parents, leading to reduced confidence in their mathematical or technical abilities (UNESCO, 2017).

At the national level, the Ghanaian government has prioritised STEM education as a key strategy for development. Policies such as the Education Strategic Plan (2018–2030) and the Girls' Education Policy aim to promote equity and expand access to STEM opportunities, particularly for girls. Ghana's Education Strategic Plan (2018–2030) prioritises STEM education as a pathway to national development and innovation. The Girls' Education Policy and the introduction of STEM schools aim to improve equity and access. However,

implementation challenges persist, including inadequate resources, limited teacher training in gender-responsive pedagogy, and a lack of systematic mentorship for female students. Public universities like KNUST, UCC, and UEW have initiated female-focused scholarships and STEM outreach activities, but more targeted interventions are needed to address the persistent gender gap in STEM enrolment and achievement.

Theoretical framework

The Social Cognitive Career Theory (SCCT) is a model that elucidates how individual inputs, contextual factors, and socio-cognitive variables shape occupational interests, career goals, and behaviours (Zola et al., 2021). Initially introduced by Albert Bandura in 1986 (Yusoff, 2019), SCCT was later developed by Robert Lent and Steven Brown in 2005 to encompass background variables, self-efficacy, and outcome expectations in vocational interests and career choices (Foley and Lytle, 2015). In 2013, researchers expanded SCCT to highlight satisfaction and well-being in academic and professional realms, along with managing developmental tasks and challenges (Foley and Lytle, 2015; Lent and Brown, 2017). Schoenfeld et al. (2017) argue that SCCT serves as a comprehensive framework for understanding the processes leading to academic and career choices. Rino et al. (2023) outline three interrelated models within SCCT that address interest development, choice-making, and performance, emphasising how self-efficacy and outcome expectations influence career decisions.

Prawitasari (2018) notes that multigenerational labour introduces new career challenges, highlighting SCCT's insights into generational self-efficacy beliefs. Dos Santos (2018) emphasises SCCT's consideration of social, cultural, and economic factors in employment decisions, making it a valuable tool for contemporary career counselling (Wang et al., 2022). Despite some methodological limitations (Wang et al., 2022), SCCT remains highly applicable in school career education and enhances students' decision-making (Lent and Brown, 2019; Kusumawati and Wahyuningsih, 2020).

This study is grounded in the Social Cognitive Career Theory (SCCT), which explains how career choices are shaped by personal, contextual, and behavioural factors, particularly self-efficacy, outcome expectations, and goal-setting (Lent et al., 1994). The Social Cognitive Career Theory (Lent et al., 1994) informed the design, instrumentation, and analysis of this study. SCCT posits that career development is shaped by the interaction of self-efficacy, outcome expectations, and contextual influences such as family and school environment. The study's research questions were developed based on SCCT's core components—personal factors (self-efficacy, interest), social/contextual influences (parental involvement, role models, counselling), and environmental facilitators or barriers. The quantitative instrument measured constructs aligned with SCCT—e.g., perceived parental involvement and career counselling as contextual supports, role models as outcome expectations. Qualitative questions were designed to explore how these factors are experienced and perceived by students. During data analysis, themes were mapped against SCCT domains, demonstrating how personal and environmental factors interact to shape STEM career choices.

Statement of the Problem

Research highlights the importance of parental influence, effective career counselling, and exposure to role models in shaping girls' interest and confidence in STEM. Studies by Iddrisu et al. (2023), Gülhan (2023), and Svoboda et al. (2016) emphasise the role of supportive home environments, while Karahan et al. (2021) and Guenaga et al. (2022) demonstrate how career guidance and female role models positively affect girls' STEM aspirations. Despite increasing recognition of the importance of girls' participation in STEM for national development, Ghana continues to experience low female representation in STEM programmes at the tertiary level. While existing research acknowledges the impact of parental background, counselling, and mentorship, limited attention has been given to how these factors interact to influence university-level career decisions in the Ghanaian context. Furthermore, national policy efforts to promote female inclusion in STEM lack detailed, institution-specific data to inform targeted interventions. This study seeks to fill that gap by providing empirical evidence on the contextual, personal, and social influences that affect Ghanaian girls' STEM career choices at the university level.

Research Objectives

Based on the identified problem and the existing literature gap, the present study was guided by the following specific objectives:

1. Investigate the influence of parental educational attainment on girls' choice of STEM-related careers at the tertiary level.
2. Assess the impact of parental involvement on students' STEM career decisions.
3. Evaluate how career counselling affects girls' inclination towards STEM careers.
4. Examine the effect of exposure to STEM role models on students' career choices.

5. Explain how these personal, contextual, and social factors interact to shape career trajectories in STEM among Ghanaian female undergraduates.

Research Questions

1. To what extent does parental educational attainment (both fathers' and mothers') influence girls' choice of STEM-related careers at the tertiary level?
2. What is the impact of parental involvement on girls' choice of STEM-related careers at the tertiary level?
3. What is the impact of career counselling on girls' choice of STEM-related careers at the tertiary level?
4. What is the impact of role models on girls' choice of STEM-related careers at the tertiary level?
5. How do key factors influence girls' choice of STEM careers?

Scope of the Study

This study focused on level 400 female undergraduate students enrolled in STEM programmes at three public universities in Ghana: The University of Education, Winneba (UEW); the University of Cape Coast (UCC); and the Kwame Nkrumah University of Science and Technology (KNUST). It examined four major variables—parental educational attainment, parental involvement, career counselling, and exposure to role models—based on the Social Cognitive Career Theory. Data were collected through structured questionnaires (n = 424) and semi-structured interviews (n = 15). The study is geographically restricted to three public universities in Ghana, and its findings are specific to the sampled universities and may not represent the entire country.

METHODOLOGY

Study Context

The study was conducted in three major public universities in Ghana: University of Education, Winneba (UEW), known for its focus on teacher education. UEW offers a range of science and mathematics education programmes and is actively involved in gender-inclusive initiatives. University of Cape Coast (UCC), a coastal institution with robust programmes in biological sciences, chemistry, and mathematics. UCC promotes STEM education through its Centre for Gender Research, Advocacy and Documentation (CEGRAD). Kwame Nkrumah University of Science and Technology (KNUST), Ghana's premier science and technology university. KNUST has the highest female STEM enrolment among the three. It also partners with various NGOs and industries to advance female participation in engineering and computing fields. These universities represent a cross-section of Ghana's STEM higher education environment, providing a balanced view of student experiences and institutional support.

Research Design

The study adopted a mixed-methods approach to provide a comprehensive understanding of the factors influencing girls' decisions to pursue STEM careers. The quantitative phase collected data through structured questionnaires from 424 female STEM students, allowing for statistical analysis of the relationships between parental educational attainment, parental involvement, career counselling, role models, and STEM career choices. To complement the numerical findings, the qualitative phase involved semi-structured interviews with 15 participants, selected through purposive sampling to ensure diverse perspectives. The decision to interview 15 participants was based on the principle of data saturation, which occurs when additional interviews no longer yield new insights (Guest et al., 2006). Previous research has established that data saturation in qualitative studies is often achieved within 6 to 12 interviews (Guest et al., 2006; Creswell and Creswell, 2018). Thus, conducting 15 interviews exceeded the established threshold for ensuring comprehensive thematic coverage.

The integration of qualitative and quantitative data followed an explanatory sequential design, where the qualitative data helped contextualise and interpret the statistical trends observed in the quantitative analysis (Creswell and Creswell, 2018). For instance, while regression analysis quantified the strength of relationships, the interview data provided deeper insight into why certain parental influences or role models were particularly impactful. The interviews were strategically designed to complement the quantitative findings by capturing in-depth narratives on participants' experiences with parental involvement, career counselling, and role models in STEM. The selection process ensured representation from diverse STEM fields and backgrounds, enhancing the richness of the data. This approach ensured that numerical trends were not only presented statistically but also understood in the lived experiences of the participants, reinforcing the study's findings and enhancing their real-world applicability. The methodological rigour of this mixed-methods approach strengthens the validity of the qualitative findings and their ability to support the broader claims made in the discussion.

Table 1. Age distribution of the respondents

Age	Frequency (N)	Percentage (%)
18–20	108	25.5
21–25	275	64.9
26–30	30	7.1
31 and above	11	2.5
Total	**424**	**100**

Source: Fieldwork, 2024

Table 2. Population distribution for level 400 students in STEM programmes

Institutions	Number	Male	Percentage (%)	Female	Percentage (%)
University of Education (A)					
Department of Math	306	186	61	120	39
Department of Physics	560	458	81	102	19
Department of ICT	71	65	92	6	8
Department of Biology	145	107	74	38	26
Department of Chemistry	83	74	89	9	11
Sub-total	**1,165**	**890**	**76**	**275**	**24**
University of Cape Coast (B)					
Faculty of Science and Technology Education	317	213	67	104	33
School of Physical Sci.	887	636	72	251	28
School of Biological Sci.	664	452	68	212	32
Sub-total	**1,868**	**1,301**	**70**	**567**	**30**
KNUST (C)					
College of Engineering	1,076	853	79	223	21
College of Science	1,022	735	72	287	28
Sub-total	**2,098**	**1,588**	**76**	**510**	**24**
Total	**5,483**	**3,879**	**71**	**1,352**	**29**

Source: Fieldwork, 2024

Population/Sampling Technique/Sampling Size

The study specifically targeted all level 400 female students, who were enrolled in the Basic and Applied Science departments at the selected universities. This was due to their longer university tenure and completion of most STEM courses, which placed them in a position to provide accurate and relevant responses to the factors influencing girls' decisions to pursue STEM careers. The population of female students across the three universities is 1,352. **Table 1** displays the respondents' age distribution.

Table 1 shows that the majority of the participants are in the 21–25 age range, comprising 64.9% of the total sample (275 out of 424 respondents). **Table 2** shows the population distribution for students at level 400.

A stratified random sampling technique was used to select the sample from the population. First, the population was divided into homogeneous groups: University of Education, Winneba (UEW); University of Cape Coast (UCC); Kwame Nkruma University of Science and Technology (KNUST). Hasan and Kumar's (2024) sample size formula determined the participants per stratum, including departments. From a population of 1, 352, the required sample size was 299; however, 424 female STEM students participated in the study to account for potential non-responses, sampling errors couple with the fact that the students were writing their end of semester examination at the time. The distribution was 97 from UEW, 171 from UCC and 156 from KNUST, ensuring each university's representation reflects its population share.

During the qualitative phase of the research, a purposive sampling technique was used to select 15 participants for semi-structured interviews—five from each of the three universities—to capture diverse perspectives. At UEW, one participant was selected from each of the five STEM-related departments. At UCC, one participant came from the Faculty of Science and Technology Education, two from the School of Physical Sciences, and two from the School of Biological Sciences. At KNUST, two participants were drawn from the College of Engineering and three from the College of Science. The distribution of participants across the universities was proportionally determined based on their respective sample sizes in the quantitative phase. Although 20 volunteers were initially selected, only 15 ultimately participated in the interviews. **Table 3**, **Table 4**, and **Table 5** present this sample distribution.

Table 3. Sample distribution for female students population (UEW) (University A)

Programmes	Sample size required
Department of Mathematics	40
Department of ICT	31
Department of Physics	6
Department of Biology	14
Department of Chemistry	6
Total	**97**

Source: Fieldwork, 2024

Table 4. Sample distribution for female students population (UCC) (University B)

Programmes	Sample size required
Faculty of Science and Technology Education	
Department of Vocational and Technology	20
Department of Science Education	6
Department of Math and ICT Education	7
Sub-total	**33**
School of Physical Sciences	
Department of Chemistry	15
Department of Computer Science and Information Technology	8
Department of Laboratory Technology	6
Department of Mathematics	13
Department of Statistics	24
Department of Water and Sanitation	10
Sub-total	**76**
School of Biological Sciences	
Department of Biochemistry	9
Department of Conservation Biology and Entomology	9
Department of Environmental Sciences	9
Department of Fisheries and Aquatic Science	10
Department of Forensic Sciences	10
Department of Molecular Biology and Biotechnology	15
Sub-total	**62**
Total	**171**

Source: Fieldwork, 2024

Table 5. Sample distribution for female students population (KNUST) (University C)

Programmes	Sample size required
College of Engineering	
Civil Engineering	8
Petroleum Engineering	15
Chemical Engineering	15
Computer Engineering	8
Electrical Engineering	11
Petrochemical Engineering	9
Marine Engineering	3
Sub-total	**69**
College of Science	
Chemistry	23
Computer Science	17
Mathematics	12
Physics	10
Meteorology	8
Food Science and Technology	9
Biochemistry and Biotechnology	8
Sub-total	**87**
Total	**156**

Source: Fieldwork, 2024

Table 6. Parental educational attainment

Educational attainment	Father		Mother	
	Frequency (N)	Percentage (%)	Frequency (N)	Percentage (%)
No formal education	4	0.9	4	0.9
JHS certificate	62	14.6	122	28.8
SHS certificate	121	28.5	127	30.0
HND certificate	59	13.9	48	11.3
First degree (bachelor's degree)	127	30.0	86	20.3
Second degree (masters)	35	8.3	28	6.6
Third degree (PhD)	16	3.8	9	2.1

Source: Fieldwork, 2024

Data Collection Instruments

A questionnaire adapted from established instruments (Cohen et al., 2018; Saah et al., 2023; Appianing and Van Eck, 2018; Iddrisu et al., 2023; Tapia and Marsh, 2004; Chen et al., 2024) was used for the quantitative portion of this study, achieving a reliability coefficient of 0.7.

The questionnaire was structured using a Likert scale format (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree) to measure the degree of agreement or disagreement with various statements/items related to the subconstruct.

The Likert-scale questionnaire collected data on factors affecting girls' STEM career choices in the three prominent universities in Ghana, including parental educational attainment, parental involvement, role models, and career counselling. Structured into five sections, the first section focused on the demographic's information and the remaining four sections aligned with the research questions and covered parental educational impact (20 items), parental involvement (19 items), career counselling (30 items), and role models (20 items).

A pilot test with 72 students, following Van Teijlingen et al.'s (2001) guidance, was conducted to refine the questionnaire for cultural relevance and measurement accuracy. Feedback led to enhancements, improving reliability and validity for the main study. Expert reviews supported content validity, factor analysis assessed construct validity, and comparison with established benchmarks ensured criterion-related validity. Random sampling strengthened external validity, while precise variable definitions reduced ambiguity.

A semi-structured interview guide, informed by a literature review and quantitative survey findings (Creswell and Creswell, 2018), was developed to gain further insights and answer the fifth research question. Guba and Lincoln's (1985) trustworthiness criteria guided qualitative reliability: credibility was reinforced through participant response reviews, transferability through contextual descriptions, dependability via research process documentation, and confirmability by bias reflection. Data collection spanned May 2024, with questionnaires taking 30–40 minutes and interviews lasting 20 minutes. Linear regression analysed continuous influences like parental support, career counselling and role models against the continuous outcome of girls' STEM career intentions. Interview transcripts were analysed using Braun and Clarke's (2006) thematic coding approach, ensuring accurate reflection of participants' perspectives.

RESULTS

The section is in four parts. The first section analyses the respondents' parental educational attainment and parental involvement. **Table 6** displays the respondents' parental educational attainment with its regression analysis in **Table 7**. **Table 8** then displays parental involvement, and **Table 9** presents its corresponding regression analysis. The second section presents the career counselling data (**Table 10**) and its corresponding regression analysis (**Table 11**). The third section presents information on role models in **Table 12** and their corresponding regression analysis in **Table 13**. Finally, the fourth section focused on the qualitative aspect of the study.

Research Question One: To what extent does parental educational attainment influence girls' declaration of STEM-related careers at the tertiary level?

This research question aimed to determine the influence of parental educational attainment on students' declaration of STEM-related careers at the tertiary level. Frequency counts and percentages were initially used to analyse the data, followed by a regression analysis, with parental educational attainment as the independent variable and choice of STEM-related careers as the dependent variable.

Table 6 presents the descriptive analysis of parental educational attainment. Only a small percentage of fathers and mothers (0.9%) had no formal education, suggesting that most parents had received at least some schooling.

Table 7. Regression analysis of parental educational attainment and girls' choice of STEM-related careers at the tertiary level

Variables	Unstandardized coefficients		Standardized coefficients	t	Significance
	B	Standard error	Beta		
(Constant)	3.374	.080		42.235	.001
Fathers' education attainment	.005	.032	.010	.147	.883
Mothers' education attainment	.004	.032	.009	.132	.895

Significant at $p > 0.05$; $F = .058$; $df = (2, 421)$; Multiple $R = 0.017$; $\mathbf{R^2 = .000}$
Source: Fieldwork, 2024

Table 8. The descriptive statistics of students' responses about their parental involvement

Items	Mean	SD	CV
My parents believe that gender should not be a barrier to pursuing a STEM career	3.92	.964	24.59
My parents provide positive reinforcement when I express interest in STEM fields	3.88	.972	25.05
My parents believe in the ability of girls to excel academically and professionally in STEM fields.	3.85	.940	24.42
My parents have high expectations for my success in STEM-related courses and careers	3.84	.960	25.00
My parents believe that girls are as capable as boys in STEM subjects.	3.83	.944	24.65
My parents celebrate my achievements in STEM subjects.	3.82	.963	25.21
My parents believe that STEM fields are accessible and suitable for everyone, regardless of gender.	3.81	.982	25.77
My parents expect me to perform well in STEM subjects.	3.79	.964	25.44
My parent provides resources (e.g., books, internet) to help me excel in STEM subjects	3.72	1.044	28.06
My parents actively support my interest in STEM subjects.	3.72	1.010	27.15
My parents are aware of and encourage participation in STEM-related extracurricular activities.	3.71	.980	26.42
My parents support initiatives that promote STEM education for girls.	3.69	1.002	27.15
My parents encouraged me to take advanced STEM courses in school.	3.61	1.044	28.92
My parent has encouraged me to consider a STEM-related career.	3.59	1.048	29.19
My parents have a mindset that strongly promotes STEM education and careers for girls.	3.53	1.085	30.74
My parent usually encouraged me to pursue a STEM-related programme at the university.	3.41	1.139	33.40
Discussions about STEM careers are common in my household	3.40	1.087	31.97
My parent has provided guidance on how to succeed in STEM-fields.	3.33	1.080	32.43
Seeing my parent succeed in STEM careers inspires me to pursue a similar path.	3.13	1.126	35.97
Grand mean	**3.66**	**.209**	

Source: Fieldwork, 2024

Mothers were almost twice as likely (28.8%) as fathers (14.6%) to hold a junior high school (JHS) certificate, indicating that JHS completion was more common among mothers. At the senior high school (SHS) level, both fathers (28.5%) and mothers (30.0%) had similar educational attainment.

More fathers (13.9%) than mothers (11.3%) held a Higher National Diploma (HND), reflecting a slightly higher likelihood of fathers pursuing vocational education. A notable difference appeared at the bachelor's degree level, with 30.0% of fathers compared to 20.3% of mothers holding this degree, indicating a higher attainment of undergraduate education among fathers. Additionally, fathers were more likely to hold a master's degree (8.3%) than mothers (6.6%) and were almost twice as likely to have a PhD (3.8% vs. 2.1%). Overall, fathers demonstrated higher educational attainment at the bachelor's, master's, and PhD levels, whereas mothers were more prevalent at the JHS level. Both groups had similar attainment at the SHS level, underscoring a general focus on completing secondary education.

The regression model did not find a significant relationship between parental educational attainment (both fathers' and mothers') and the choice of STEM-related careers (**Table 7**). Fathers' educational attainment ($B = 0.005$, $p = 0.883$) and mothers' educational attainment ($B = 0.004$, $p = 0.895$) did not significantly predict students' career choices. The overall model fit [$F(2,421) = 0.058$, $R^2 = 0.000$] indicated no explanatory power.

Research Question Two: What is the impact of parental involvement on girls' choice of STEM-related careers at the tertiary level

This research question aimed to determine the influence of parental involvement on girls' choice of STEM-related careers at the tertiary level. The descriptive statistics were complemented with a regression analysis that was conducted with parental involvement as the independent variable and choice of STEM-related careers as the dependent variable. **Table 8** and **Table 9** present the results of the analyses.

Table 9. Regression analysis of parental involvement and its impact on girls' choice of STEM-related careers at the tertiary level

Variables	Unstandardized coefficients		Standardized coefficients	t	Significance
	B	Standard error	Beta		
(Constant)	1.373	.129		10.657	.000
Parental involvement	.553	.034	.616	16.053	.000

Significant at $p < 0.05$; $F = 257.689$; $df = (1, 422)$; Multiple $R = 0.616$; $\mathbf{R^2 = .379}$
Source: Fieldwork, 2024

Table 10. Descriptive statistics of students' responses about career counselling

Items	Mean	SD	CV
I believe I can excel in a STEM-related career with proper counselling support.	3.73	.960	25.74
I am confident in my ability to succeed in STEM subjects with the help of the counsellor.	3.60	.968	26.89
I believe that counselling about STEM careers are exciting and engaging.	3.52	.967	27.47
Counselling through success stories by women in STEM related field have inspired me.	3.46	.993	28.70
Counselling has shown me that STEM professionals can make a positive impact on society.	3.46	.991	28.64
My school offers counselling programmes specifically targeting girls' participation in STEM fields.	3.44	1.020	29.65
My school offers counselling services that provide detailed information on the benefits of pursuing STEM careers.	3.30	1.004	30.42
Career counselling sessions have made me more interested in STEM-fields.	3.14	1.001	31.88
Career counselling has helped me understand the different STEM career opportunities available	3.14	1.035	32.96
I lack counselling support in making academic and career decisions related to STEM	3.06	1.061	34.67
Counselling sessions have connected me with STEM professionals for guidance and mentorship.	3.03	1.035	34.16
I have a female relative working in a STEM field who has influenced my career choices through counselling.	3.00	1.146	38.20
I have received career counselling specifically focusing on STEM-fields.	2.99	1.058	35.38
I have a mentor who provides counselling for my STEM-related academic or career decisions.	2.94	1.025	34.86
I have discussed my STEM career options with a career counsellor.	2.84	1.037	36.51
Grand mean	**3.24**	**.265**	

Source: Fieldwork, 2024

The results indicated strong student agreement with statements regarding parental involvement in their STEM career choices. Notably, students felt that "My parents believe that gender should not be a barrier to pursuing a STEM career" (Mean = 3.92, SD = .964) and that they received positive reinforcement for their interests (Mean = 3.88, SD = .972). Additionally, parents were viewed as believing in girls' potential in STEM (Mean = 3.85, SD = .940) and maintaining high expectations for success (Mean = 3.84, SD = .960). Other agreements included celebrating achievements (Mean = 3.82, SD = .963) and discussing STEM careers at home (Mean = 3.40, SD = 1.087).

The regression analysis (**Table 9**) revealed a strong model fit [$F(1,422) = 257.689$, $p < 0.05$], indicating that parental involvement significantly influences students' STEM career choices. The R-squared value (.379) suggests that parental involvement accounts for 37.9% of the variance in students' career decisions. Furthermore, the Beta coefficient ($\beta = 0.553$, $p < 0.05$) shows that an increase in parental involvement is associated with a .553 increase in students' likelihood of choosing STEM-related fields. The regression model is:

Choice of STEM-related Field = 1.373 + .553 (Parental Involvement).

Research Question Three: What is the impact of career counselling on girls' choice of STEM-related careers at the tertiary level?

This research question aimed to determine the influence of career counselling on students' STEM-related career choices at the tertiary level. The descriptive statistics were analysed first, followed by a regression analysis using career counselling as the independent variable and choice of STEM-related careers as the dependent variable. **Table 10** and **Table 11** present the results of these analyses.

The data on career counselling in STEM indicates that students generally viewed career counselling positively, recognising its role in shaping their academic and career decisions (Grand Mean = 3.24). Specifically, students agreed with the statements: "I believe I can excel in a STEM-related career with proper counselling support" (Mean = 3.73, SD = 0.960). They also expressed confidence in succeeding in STEM subjects with counsellor assistance (Mean = 3.60, SD = 0.968) and found counselling about STEM careers engaging (Mean = 3.52, SD = 0.967). However, students disagreed with statements indicating they had received targeted STEM counselling (Mean = 2.99, SD = 1.058) or discussed career options with a counsellor (Mean = 2.84, SD = 1.037). These findings suggest

Table 11. Regression analysis of career counselling and its impact on girls' choice of STEM-related careers at the tertiary level

Variables	Unstandardized coefficients		Standardized coefficients	t	Significance
	B	Standard error	Beta		
(Constant)	1.241	.128		9.678	.000
Career counselling	.665	.039	.641	17.166	.000

Significant at $p < 0.05$; $F = 294.680$; $df = (1, 422)$; Multiple $R = 0.641$; $\mathbf{R^2 = .411}$
Source: Fieldwork, 2024

Table 12. Exposure to STEM role models

Items	Mean	SD	CV
I believe that a career in STEM offers good job security, as seen in the careers of STEM role models	3.60	.970	26.94
Seeing women as STEM role models has made me feel that I belong in the STEM field.	3.59	.990	27.58
I aspire to follow in the footsteps of the STEM role models I admire.	3.53	.987	27.96
My STEM role models argue that STEM careers offer opportunities to make significant contributions to society.	3.52	.977	27.76
Encouragement from STEM role models has boosted my confidence in pursuing a STEM career.	3.49	.970	27.79
Mentorship from individuals in STEM careers has been crucial in shaping my career aspirations.	3.45	.990	28.70
Having role models in STEM has increased my interest in pursuing a STEM career	3.44	.983	28.58
I feel well-prepared for a career in STEM, thanks to the influence of STEM role models	3.43	.950	27.70
The presence of STEM role models has influenced my choice of programme in school.	3.42	.965	28.22
I would take a course in STEM even if it were not required due to the inspiration from STEM role models.	3.41	.939	27.54
I don't dislike STEM courses because of the positive influence of STEM role models	3.41	.963	28.24
Learning about the career paths of STEM role models has helped me make informed decisions about my career.	3.41	.978	28.68
I find STEM-related jobs very interesting because of the influence of my role models.	3.40	1.015	29.85
My role models in STEM influence me about greater achievement in my professional aspirations if I pursue STEM-related career.	3.40	.957	28.15
I receive encouragement from role models to pursue STEM careers.	3.39	1.005	29.65
I have a role model who helps me consider my STEM-related academic and career options	3.26	1.065	32.67
Grand mean	**3.449**	**.0813**	

Source: Fieldwork, 2024

that while students recognise the value of career counselling, many do not have direct access to structured STEM-specific guidance.

The regression analysis (**Table 11**) confirmed that career counselling significantly predicted students' STEM career choices [$F(1,422) = 294.680$, $p < 0.05$], accounting for 41.1% of the variance ($R^2 = 0.411$). The positive coefficient ($\beta = 0.665$, $p < 0.05$) indicates that increased career counselling in mathematics is associated with a 0.665 increase in the likelihood of choosing STEM-related fields. The regression model is:

Choice of STEM-related Field = 1.241 + 0.665 (Career Counselling in Mathematics).

Research Question Four: What is the impact of role models on girls' choice of STEM-related careers at the tertiary level?

This research question aimed to determine how exposure to STEM role models influences girls' choice of STEM-related careers at the tertiary level. Descriptive statistics were analysed first, followed by a regression analysis with exposure to role models as the independent variable and choice of STEM-related careers as the dependent variable. **Table 12** and **Table 13** present the results of these analyses.

The findings indicate that students generally hold a positive perception of STEM careers, significantly influenced by the presence of STEM role models (Grand Mean = 3.449, SD = .0813). Students strongly agreed with the statement: "I believe that a career in STEM offers good job security, as seen in the careers of STEM role models" (Mean = 3.60, SD = 0.970), highlighting their recognition of job stability associated with these careers. Furthermore, the impact of female STEM role models is evident, as shown in the statement, "Seeing women as STEM role models has made me feel that I belong in the STEM fields" (Mean = 3.59, SD = 0.990), suggesting that representation is key to fostering a sense of belonging among students.

Additionally, students agreed with several other statements reflecting the influence of role models: "I feel well-prepared for a career in STEM, thanks to the influence of STEM role models" (Mean = 3.43, SD = .950); "The presence of STEM role models has influenced my choice of programme in school" (Mean = 3.42, SD = .965); and "I would take a course in STEM even if it were not required due to the inspiration from STEM role models"

Table 13. Regression analysis of role models and its impact on girls' choice of STEM-related careers at the tertiary level

Variables	Unstandardized coefficients		Standardized coefficients	t	Significance
	B	Standard error	Beta		
(Constant)	1.135	.113		10.046	.000
Role models	.657	.032	.706	20.471	.000

Significant at $p < 0.05$; $F = 491.066$; $df = (1, 422)$; Multiple $R = 0.706$; $\mathbf{R^2 = .498}$
Source: Fieldwork, 2024

(Mean = 3.41, SD = .939). Overall, the data underscores the critical role that STEM role models play in shaping students' perceptions and aspirations toward STEM careers.

The regression analysis (**Table 13**) confirmed that exposure to role models was the strongest predictor of students' STEM career choices [$F(1,422) = 419.066$, $p < 0.05$], accounting for 49.8% of the variance ($R^2 = 0.498$). The positive coefficient ($\beta = 0.657$, $p < 0.05$) indicates that increased exposure to role models is associated with a 0.657 increase in the likelihood of choosing STEM-related fields. The regression model is:

Choice of STEM-related Field = 1.135 + 0.657 (Role Models).

Research Question Five: How do key factors influence girls' choice of STEM careers?

To explore the factors influencing girls' decisions to pursue STEM careers, semi-structured interviews were conducted with 15 participants. Initially, twenty students volunteered, but only fifteen proceeded with the one-on-one interviews, which were guided by a single question: "What factors influence your choice of STEM-related careers?" The data was analysed using deductive (or theoretical) thematic analysis. In this approach, the responses were sorted into themes that were already generated from reviewed literature (Shulga et al., 2023). The qualitative data provided a deeper understanding of how multiple factors interact to shape students' career aspirations. While the regression models quantified the significance of key influences, the interviews revealed the motivations, barriers, and personal experiences that contributed to students' decisions.

Parental Educational Attainment

Despite the statistical insignificance of parental educational attainment, qualitative findings revealed that students valued encouragement and exposure to STEM more than their parents' level of education. Some students expressed that their parents' education did not directly influence their career decisions:

> T1: My parents are both highly educated, but that didn't directly influence my choice of STEM. My decision came from my love for problem-solving, technology and a role model (an engineer), rather than their educational background.
>
> T2: Neither of my parents went to university, but they always encouraged me to work hard in math and science. I think their support mattered more than their level of education.
>
> T5: My mom always pushed me to explore science, and I actually found that I really enjoyed it, especially biology. She would bring home books and let me do experiments at home, which made learning fun. It's a mix of her encouragement and my own interest that made me want to pursue a career in medical research, plus my father's mechanic skills.
>
> T6: My dad is a professor, and my mom is a businesswoman, but their educational background never really influenced my decision. What mattered was their encouragement and the resources they provided.
>
> T13: I've been interested in designing things since I was little, but I thought that was more of a creative field. My parents always encouraged me to keep exploring different subjects, so when I got interested in programming, they supported me. Combining my interest in design with technology has opened up new possibilities, like web development, which I hadn't considered before.

These narratives highlight that parental support, encouragement, and resource provision have a greater impact on students' STEM career choices than their parents' formal education. Beyond academic qualifications, parents who actively encourage their daughters and challenge gender stereotypes play a crucial role in boosting their confidence to pursue STEM careers. This underscores the importance of parental involvement in fostering a love for science through hands-on activities, mentorship, and access to STEM-related resources, ultimately shaping students' aspirations and career choices.

Parental Involvement

While the quantitative results confirmed the strong influence of parental involvement, the qualitative findings provided insight into the nature of this involvement. Several participants described how their parents actively engaged in their career development by discussing STEM opportunities, providing resources, and celebrating their achievements.

> T3: My parents never studied STEM, but they always told me I could achieve anything. Their confidence in me and seeing women in science and tech made me believe I could pursue a career in STEM.
>
> T4: My dad used to buy me science kits when I was little, and we would conduct experiments together. I think that's what made me love science.
>
> T5: I knew I wanted to be an engineer when I saw how my father, a mechanic, would solve technical problems. Even though he's not formally educated, he inspired me to think critically.

One participant shared a transformative experience:

> T6: My parents always encouraged me to do well in math, but I never really thought about pursuing a STEM career until I saw women excelling in these fields. When I met a female scientist during a school event, it changed how I viewed STEM careers. My parents' support, combined with seeing women like her succeed, made me believe I could follow the same path.

These narratives emphasise that parental involvement extends beyond academic qualifications to practical engagement and encouragement, influencing how students perceive STEM fields and their own capabilities within them.

Career Workshops or Counselling

While the quantitative results confirmed the significant impact of career counselling, the qualitative findings provided insight into the variations in accessibility and effectiveness. Students shared different experiences based on the availability and timing of counselling.

> T2: I wasn't sure what I wanted to do, but after a career counselling we had in our school, I started considering STEM fields. They helped me understand my strengths and showed me paths I hadn't thought of before. I think more girls would be interested in STEM if they had proper guidance like this.
>
> T6: I had no idea what engineering was until our career counsellor explained it to me. Without that session, I probably wouldn't have considered STEM.
>
> T7: Career counselling was helpful, but it came too late. I wish we had been exposed to STEM careers earlier in secondary school.
>
> T8: I didn't think STEM was for girls until I attended a career fair where female engineers spoke about their journeys. That session changed my perspective completely.
>
> T9: I love solving problems, and I've been good at math for as long as I can remember. But I didn't know what careers would fit with that until I met with a career advisor. They introduced me to fields like data analysis and artificial intelligence, which combine my interests in math and tech….
>
> T11: I only started considering STEM when my school counsellor explained how my math skills could be useful in engineering. But not all my friends had that experience; some didn't even know where to go for career advice…

These narratives suggest that career counselling plays a transformative role, but its impact is highly dependent on accessibility and early intervention. Career workshops and counselling sessions significantly influence girls' decisions regarding STEM careers by providing structured guidance and exposing them to diverse career opportunities. Through these sessions, students gain insights into various STEM fields, helping them recognise that these careers are not only attainable but also aligned with their abilities and aspirations. This highlights the importance of professional advice in broadening students' horizons, making STEM fields more accessible and appealing. Furthermore, career counselling serves as a crucial bridge between students' strengths, interests, and potential career paths, ensuring that they make informed choices that match their skills and ambitions.

Role Models

The qualitative data reinforced the quantitative findings, with multiple participants highlighting the transformative role of role models in shaping their career aspirations.

> T1: I've always been curious about how things work, but I didn't really think about a career in STEM until I met a female engineer during a school programme. Seeing her in that role changed my perception. I realised that women could succeed in fields like engineering, and that motivated me to explore similar careers.
>
> T3: Meeting women who are working in STEM fields makes a big difference. Before, I thought these jobs were mostly for men, but seeing women like scientists or tech professionals makes me feel like it's possible for me too.
>
> T10: I always loved science, but I didn't have role models. My parents supported me, but they didn't know much about STEM careers. I had to figure things out on my own. Until I met a female doctor who visited our school, I thought medicine was too difficult for me. Seeing her success made me believe I could do it too.
>
> T9: …and one of my biggest inspirations is my aunt, who is a software developer. She showed me that women can thrive in tech fields.
>
> T11: …and hearing the stories of women in STEM at a conference motivated me to pursue a career in engineering.
>
> T12: I never saw women in STEM on TV or in my community. When I finally met a female scientist, it felt like a breakthrough moment for me.

These highlight the importance of representation and how seeing successful women in STEM can challenge stereotypes and inspire girls to pursue similar paths. Exposure to female STEM professionals plays a transformative role in reshaping students' perceptions, boosting their confidence, and breaking gender-based barriers associated with STEM fields. When combined with professional guidance, role models help students envision themselves in STEM careers, making these fields feel more accessible and achievable.

The findings indicate that the presence or absence of role models and career counselling significantly shaped students' STEM career choices. While some students benefited from exposure to mentors and structured career guidance, others had to rely on personal interest and self-motivation in the absence of external support. One student shared:

> T10: I always loved science, but I didn't have role models. My parents supported me, but they didn't know much about STEM careers. I had to figure things out on my own.

This response underscores the importance of role models and access to career counselling in shaping students' career aspirations. It confirms the Social Cognitive Career Theory (SCCT), which suggests that self-efficacy and outcome expectations interact with contextual factors like role models and parental support to influence career choices (Lent and Brown, 2019). The influence of female mentors was particularly notable in inspiring students to challenge gender norms and consider STEM careers. This aligns with Riise et al. (2022), who found that female doctors positively influenced young girls to pursue male-dominated careers, emphasising the importance of relatable mentors.

The qualitative findings suggest that structured career exposure through mentorship, career counselling, and real-world engagement with STEM professionals can significantly increase students' confidence in pursuing STEM careers. These insights highlight the need for policies and educational interventions that strengthen role model programmes, improve access to STEM career counselling, and provide hands-on STEM experiences to ensure that more girls can navigate their STEM career paths with guidance and support.

DISCUSSION

This section discusses how the study's findings relate to the five research questions using an integrated mixed-methods approach. Themes from the qualitative data are used to support, contrast, and contextualise the quantitative findings.

Research Question 1: Influence of Parental Educational Attainment

Regression analysis revealed no significant relationship between parental educational attainment and girls' choice of STEM careers [$F(2,421) = 0.058$, $p > .05$, $R^2 = .000$]. This suggests that having more educated parents does not necessarily predict a daughter's likelihood of pursuing a STEM path. Qualitatively, 'Support over Schooling' emerged as a theme, where participants affirmed that encouragement and resources from parents mattered more than their academic qualifications:

> "Neither of my parents went to university, but they always encouraged me to work hard in math and science." (T_2)

This supports Lloyd et al. (2018), who found that parental encouragement has a stronger influence than educational level alone. The finding also aligns with SCCT, which posits that self-efficacy, not parental status, drives career choice.

Research Question 2: Impact of Parental Involvement

Parental involvement significantly predicted STEM career choice [$F(1,422) = 257.689$, $p < .001$], explaining 37.9% of the variance ($\beta = .553$) with the model:

STEM Career Choice = 1.373 + 0.553(Parental Involvement).

'Hands-On Encouragement' emerged as the Qualitative Theme. Many students described parental engagement that included discussions, STEM kits, and career motivation:

> "My dad used to buy me science kits when I was little. That's what made me love science." (T_4)

These findings reinforce Gülhan (2023) and Svoboda et al. (2016), who argue that engaged parenting strengthens STEM aspirations.

Research Question 3: Impact of Career Counselling

Career counselling was a strong predictor [$F(1,422) = 294.680$, $p < .001$], explaining 41.1% of the variance ($\beta = .665$):

STEM Career Choice = 1.241 + 0.665(Career Counselling).

'Too Late or Too Little' was the qualitative theme that emerged. While many valued counselling, some noted delays or lack of access:

> "Career counselling was helpful, but it came too late. I wish we had it earlier." (T_7)

These insights support Argyro (2019) and Murcia et al. (2020), who call for early and structured career counselling. Students also stressed that impactful sessions included exposure to female professionals, helping to dismantle stereotypes.

Research Question 4: Impact of Role Models

Exposure to role models was the strongest predictor [$F(1,422) = 419.066$, $p < .001$], explaining 49.8% of the variance ($\beta = .657$):

STEM Career Choice = 1.209 + 0.657(Role Models).

'Seeing is Believing' came up as the fourth qualitative theme**.** Participants repeatedly cited female STEM professionals as turning points:

> "Meeting a female engineer during a school programme changed my perception… I realised women could succeed in fields like engineering." (T_1).

This supports Diekman et al. (2010) and Guenaga et al. (2022), who found that female role models enhance belonging and ambition in STEM. Participants reported that visibility empowered them to challenge gender norms and envision success in STEM fields.

Research Question 5: Interaction of Key Factors

Quantitatively, all three contextual and social factors (parental involvement, career counselling, and role models) were significant predictors of girls' STEM choices. Role models had the highest influence ($R^2 = 0.498$), followed by career counselling ($R^2 = 0.411$) and parental involvement ($R^2 = 0.379$). Parental education had no effect.

Qualitative Synthesis reveal 'Compound Influence'. Most students attributed their decisions to a combination of support, exposure, and guidance:

> "My parents encouraged me, but it was when I saw women succeeding in STEM and had a counsellor explain my options that I truly believed I could do it." (T_6)

This interaction supports Lent and Brown's (2019) Social Cognitive Career Theory, which explains that career choices result from the combined influence of personal interest, social persuasion, and contextual opportunities.

By triangulating quantitative data with rich qualitative insights, this mixed-methods study provides a deeper understanding of the real-world drivers of female STEM engagement in Ghana.

CONCLUSION

This study examined how parental educational attainment, parental involvement, career counselling, and exposure to role models influence girls' decisions to pursue STEM careers in three public universities in Ghana. In relation to Research Question 1, the findings revealed that parental educational attainment did not significantly predict students' STEM career choices. This suggests that formal education levels of parents may be less influential than other forms of support. This aligns with Siani et al. (2020) and Lloyd et al. (2018), who similarly found that educational attainment alone does not strongly impact STEM aspirations. Rather, encouragement and availability of resources play a more critical role. For Research Question 2, both quantitative and qualitative data showed that parental involvement significantly influenced students' STEM choices, explaining 38% of the variance. Students consistently mentioned that parental encouragement, provision of materials, and conversations about STEM shaped their confidence. This supports findings from Gülhan (2023) and Babarovic et al. (2016), which emphasised the role of engaged parenting in nurturing STEM interest, regardless of parents' formal education.

Regarding Research Question 3, career counselling was found to be a strong predictor, explaining 41.1% of the variance in STEM career choice. However, qualitative findings also revealed that many students received career guidance too late or not at all. This confirms Argyro's (2019) meta-analysis and Murcia et al. (2020), who argued that early and targeted career counselling is crucial for increasing STEM engagement, particularly for underrepresented groups. For Research Question 4, the study found that exposure to STEM role models was the most significant predictor of STEM career choice ($R^2 = 49.8\%$). Students expressed how seeing women succeed in STEM challenged stereotypes and gave them the confidence to pursue similar paths. These results are consistent with Diekman et al. (2010) and Guenaga et al. (2022), who found that visible female role models substantially enhance girls' sense of belonging and interest in STEM. Regarding Research Question 5, the mixed-methods analysis demonstrated that the interaction of parental involvement, career counselling, and role models collectively shapes girls' STEM aspirations more powerfully than any single factor. The study supports the Social Cognitive Career Theory (Lent and Brown, 2019), which posits that personal and contextual factors interact with self-efficacy and outcome expectations to influence career choice. Overall, the study concludes that parental engagement, accessible and early career counselling, and visibility of relatable role models are critical for increasing female participation in STEM fields. These findings offer valuable insights for policy makers, educators, and parents, and call for coordinated efforts to create more inclusive and supportive STEM pathways for girls in Ghana.

This study provides valuable insights for stakeholders shaping STEM education and career development in Ghana. For policy makers, it offers empirical evidence to inform gender-responsive policies that promote early STEM exposure, enhance school-based career counselling, and increase access to female role models. The findings highlight the importance of structured guidance and mentorship in addressing the gender gap in STEM. Educational implementers—such as school leaders and curriculum planners—can use the results to improve counselling services and develop extracurricular initiatives that counter gender stereotypes and inspire girls to pursue STEM careers. The study also underscores the need for early and accessible STEM-specific career counselling. For students, especially girls, the study affirms the role of confidence, guidance, and relatable role models in shaping career aspirations. It encourages girls to embrace STEM pathways when given timely support and visible examples of success. Parents are identified as crucial influencers—not necessarily through their education, but through encouragement, resource provision, and open career discussions. Finally, the study calls on employers and industry partners to support mentorship, internships, and outreach programmes. Their engagement can bridge education and employment, fostering a diverse and inclusive STEM workforce for national development.

Recommendation

Policymakers and educational institutions should integrate STEM mentorship programmes, increase access to female role models, and enhance career counselling services. Career counselling services must be comprehensive

and focus specifically on STEM pathways. By integrating programmes that debunk gender stereotypes, schools can provide girls with actionable information about the various career opportunities available to them in STEM fields. Moreover, increasing the visibility of female role models in STEM is crucial. Schools should implement mentorship programmes, host guest speaker events, and launch media campaigns that highlight successful women in STEM. This visibility can inspire girls and provide them with relatable figures to guide them through their career decisions.

Schools should provide early STEM career exposure, ensuring girls receive timely guidance. Parents should actively support and engage in discussions about STEM careers, fostering a positive home environment for STEM exploration. Additionally, curriculum designers should incorporate diverse female STEM professionals into learning materials to challenge gender stereotypes. Strengthening these interventions will create a more inclusive STEM landscape, encouraging more girls to pursue and persist in STEM careers.

Suggestion for Future Studies

Future research should explore the long-term impact of STEM mentorship programs on female students' career trajectories. A longitudinal study tracking students' career progressions after exposure to career counselling and role models would provide deeper insights into their effectiveness. Additionally, investigating the role of socio-economic factors in shaping girls' STEM aspirations can offer a broader perspective. Comparative studies across different cultural and educational contexts would further enrich understanding of the barriers and enablers influencing girls' participation in STEM careers globally.

Limitations of the Study

While this study provides valuable insights into the factors influencing girls' STEM career choices, several methodological limitations should be acknowledged. First, the study focused on female students from three public universities in Ghana, which may limit the generalisability of the findings to other regions, private institutions, or culturally diverse settings. Second, although purposive sampling ensured a diversity of programmes, the self-selection of interview participants may have introduced bias, as those more inclined toward STEM may have been more willing to participate, potentially narrowing the range of perspectives. Third, the reliance on self-reported data in both the quantitative and qualitative phases may be subject to social desirability or recall biases, despite efforts to ensure anonymity and confidentiality. Additionally, the study did not account for socio-economic status, which may influence access to career counselling, mentorship, and levels of parental involvement. The focus was also limited to students' short-term perceptions and did not explore the long-term impact of role models or career counselling on STEM career persistence. Finally, the study centred on the voices of female students alone, without incorporating perspectives from parents, teachers, or career counsellors who also play critical roles in shaping career decisions. Addressing these limitations in future research—especially through longitudinal studies and multi-stakeholder perspectives—will enhance the robustness and applicability of the findings.

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Competing Interests

The authors declare that they have no relevant financial or non-financial interests to disclose.

Author Contributions

Both authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by both authors. The first draft of the manuscript was written by Samuel Temitope Jokotagba and both authors commented on previous versions of the manuscript. Both authors read and approved the final manuscript.

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