A Non-Conformist Choice: The Lifeworld of Young Women Pursuing STEM-Related TVET in Upper Secondary Technical Institutes in Ghana

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Declaration of Original Authorship

This thesis is the result of my own work and includes nothing which is the outcome of work done in collaboration except as declared in the Preface and specified in the text. I further state that no substantial part of my thesis has already been submitted or, is being concurrently submitted for any such degree, diploma or other qualification at the University of Cambridge or any other University or similar institution except as declared in the Preface and specified in the text. It does not exceed the prescribed word limit for the relevant Degree Committee.
Abstract
Researchers have studied the structural and social constraints that affect the under-participation of females in science, technology, engineering, and mathematics (STEM) and technical, vocational, education, and training (TVET). However, removing these constraints alone has not improved young women’s participation in STEM-related TVET courses. Consequently, this research contends that exploring the lived experiences of girls who study STEM-related TVET courses and analysing TVET policy design can provide insights into enablers that can improve young women’s STEM-related TVET education and career choices. The current study employed the expectancy-value theory of achievement-related choice as the theoretical framework to investigate the research questions. The interpretative phenomenological analysis of 26 young women sampled from four Technical Institutes in Ghana’s Central and Northern regions revealed five core themes. These core themes emphasised the duality of young women’s lived experiences that harnessed their identities, agency, and capabilities. An original contribution of the study is that enablers, such as practical learning modes, career guidance and counselling, and inclusive school environments, are crucial to improving young women’s agency to make STEM-related TVET education and career choices. The study recommends reconceptualising STEM-related TVET policies to move beyond human capital to adopt the critical-capability approach of TVET.
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“To him who by means of his power working in us is able to do so much more than we can ever ask for, or even think of: to God be the glory in the church and in Christ Jesus for all time, forever and ever! Amen” (Ephesians 3:20-21)
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Chapter 1. Introduction

1.1 The Problem Space

The purpose of the current research was to explicate the lived experience of being a young woman studying science, technology, engineering and mathematics (STEM)-related technical and vocational education and training (TVET) courses in upper secondary Technical Institutes in Ghana. Of specific interest was how young women decided to study STEM-related TVET courses and the factors they had to navigate to make this non-conforming decision (a decision perceived as an odd choice for young women in Ghana). The current research was interested in understanding and explaining the young women’s experiences over their three years of study to show how their identifications developed as they navigated their experiences. A further objective was to determine the aspirational routes these young women identified as ideal to achieve their life project of becoming engineers. By studying the life world of these young women at distinct stages of their STEM-related TVET journey, this thesis presents an example of what it is like to be a young woman studying STEM-related TVET courses in Ghana. The result is a multidimensional vision of how these young women persisted in their plans and how social structures and powers influenced their adjustment during their transition as young women in STEM-related TVET pathways. The study goes on to explore the TVET policy arena. The study's findings are grounded in the distinct history, social, political, and cultural context of these particular young women. Nonetheless, the results provide evidence and knowledge that could inform policies, practices, and interventions that aim to improve the participation of young women in STEM-related TVET courses.

Historically, fewer females are more likely to receive education at all levels than males. For example, in the World Declaration on Education for All (EFA), more than 100 million children had no access to primary education, of which 60% were girls (UNESCO, 1990). A decade later, access to education for girls had not improved; thus, about 60% of 113 million children without access to primary education were still girls (UNESCO, 2000). About 92.4 million females have no access to upper secondary education compared to 84.7 million males (UNESCO UIS, 2019). Fewer females can realise educational opportunities and rights (UNESCO, 2018).

Although gender parity in education is continuing to improve under the Millennium Development Goals (MDGs) and the Sustainable Development Goals (SDGs), females in sub-Saharan Africa are less likely to receive education compared to females in other regions of the world (UNESCO, 2018). For example, by 2015, more than half of the global out-of-
school population were accessing education, and more females than males enrolled in school in some parts of Latin America, the Caribbean, the Middle East, North Africa, and Southern Africa (Tembon & Fort, 2008; UN, 2015).

However, in sub-Saharan Africa, as of 2018, most out-of-school children are females, with various disadvantages (UNESCO UIS, 2019). Thus, 21.4%, 35.3% and 54.5% of females of primary school age, lower secondary school age and upper secondary school age, respectively, were out of school in sub-Saharan Africa compared to 1.5%, 1.7% and 6.4% of females of primary school age, lower secondary school age and upper secondary school age in Europe and Northern America (UNESCO UIS, 2019). More females in sub-Saharan Africa may never enter a classroom (Tikly et al., 2018).

Additionally, fewer females enrol in STEM education, particularly in sub-Saharan Africa (Wingate, 2017). For example, about 35% of women in higher education choose to study STEM globally, except for biology, which has a higher female enrolment (WISE, 2015). Engineering, manufacturing, and construction have the lowest female enrolment. Globally 27% of students in these programmes are female, compared to 73% of males (Wingate, 2017). Country-specific data shows that only 18% of females study engineering and technology in the UK (HESA, 2019), while only 16% of females enrol in natural science, mathematics and statistics in Côte d’Ivoire (Wingate, 2017). This country-specific evidence highlights the assertion that globally the lowest proportion of females in STEM is in sub-Saharan Africa (Wingate, 2017).

Furthermore, females are unlikely to enrol in TVET, with the lowest enrolling in TVET courses that require STEM training (henceforth STEM-TVET) (UNESCO-UNEVOC, 2019). For instance, the proportion of female students in TVET is about 44% worldwide, and the enrolment of females in STEM-related TVET courses at the upper secondary level is 2.6% (UNESCO-UNEVOC, 2019; UNESCO, 2016). The lowest enrolments are in sub-Saharan Africa, where, in Kenya, fewer than 5% of females enrol in engineering and building construction TVET programmes (Ngugi, 2017). Ghana records a similar situation with low participation of women in careers like technicians and associate professionals, plant and machine operators and assemblers (Atsu & Lartey, 2018).

Typical reasons for the underrepresentation of females in STEM and STEM-TVET education are structural and social barriers. For example, UNESCO-UNEVOC (2019, (p. 1) argues that “inadequate policy frameworks, societal attitudes, the nature of STEM in the classroom and workplace affect the mindset of females to pursue education and training in STEM subjects.” Contextual factors like child marriage, poverty, early pregnancy, child
labour, gender-based violence, taboos, discrimination, family responsibilities, stigmatisation and gender stereotypes worsen the case for females of upper secondary school age living in sub-Saharan Africa (see, among others, Atsu & Larney, 2018; Mutarubukwa & Mazana, 2017; Stoet & Geary, 2018). These contextual challenges primarily impact girls in secondary education. Meanwhile, secondary education remains the critical level where subject and pathway specialisations begin. These specialisations underpin progression to higher education and, in some cases, the labour market begins (CAMFED Ghana, 2012; Hoffmann-Barthes et al., 1999; Tikly et al., 2018).

However, more countries are embracing girls’ education and empowering young women to study STEM-TVET. For instance, Ghana’s enrolment data shows that gender parity in SHS had reached 96% by the 2017 academic year, and there are now more interventions to increase female participation in education than ever before (Ministry of Education, 2018b; Tembon & Fort, 2008; UNESCO UIS, 2018). However, Watson and Jeffrey (2007, p. 25) point out that for these “interventions to increase diversity in education, they must acknowledge complex interactions among the development of self-identity, cognitive capabilities, and occupational choice.” The argument made by Watson and Jeffrey (2007) emphasises the importance and timeliness of this research, which aims to uncover the processes that underpin the choices, identification and aspirations of young women studying STEM-TVET at the International Standard Classification of Education (ISCED) Level 3 in Ghana.

The current study contends that investigating barriers to females accessing STEM-related TVET courses is insufficient for advancing measures to confront the increasing demand for equality and diversity in STEM-related TVET education at the desired pace (Stoet & Geary, 2018; Watson & Jeffrey, 2007). McDool and Morris (2020) argue that the factors that affect female STEM choices in an academic pathway differ from those that affect female STEM choices in vocational pathways. Hence there is an urgent need for further research into females’ STEM subject choices within vocational education (McDool & Morris, 2020). Consequently, I argue that it is crucial to understand the lived experiences of young women pursuing STEM-related TVET courses to expand knowledge about how to improve young women in STEM-related TVET courses. The research proposes that how young women in this study make sense of their decision to pursue STEM-TVET and their experiences can reveal mechanisms for improving gender parity in STEM-TVET. The research proposes adopting the expectancy-value theory of achievement-based choice and the
multiple attribute decision-making approaches as the theoretical framework for achieving the presented argument.

Given the paucity of knowledge about the lived experiences of young women studying STEM-related TVET courses in low-income countries, it was necessary to use a methodology that allowed young women to share their experiences without imposing existing assumptions. The methodology investigated the implications of TVET policy discourses on the under-participation of young women in STEM-related TVET courses. The current research first used a qualitative methodology, which permitted the ideographic nature of the experiences of these young women to be at the forefront of the understanding of the individual and collective experience of studying STEM-related TVET courses as a young women in Ghana (Smith, 2004).

A second qualitative method was necessary to highlight TVET policy discourses that implicitly or explicitly influenced the under-participation of young women in STEM-related TVET courses. With the employment of these qualitative methods, the findings have provided an in-depth understanding of the *how and inherent why that* defined the experiences, decisions, identities, and aspirations of the young women studied. These findings frequently underscored the complexities or distinctions of both the negative and positive meanings that becoming STEM-related TVET students had for these young women. The processes of decision-making, which explicitly show and provide an understanding of the meanings of young women’s experiences, have largely not been the emphasis of studies using quantitative methods, which dominate the existing literature. Using these qualitative approaches in the current study was particularly useful for integrating ideographic interpretations into the dominating theoretical models in this field of research. It was essential to employ a qualitative phenomenological methodology that explored the lived experiences, decision-making, identifications, and aspirations of the young Ghanaian women who chose to study STEM-related TVET courses in technical institutes in the Central and Northern regions of Ghana. It was also necessary to employ a qualitative policy analysis approach that analyses the practical argumentation approaches proposed to address the issue.

It is common to acknowledge that researchers cannot entirely detach themselves from the research process. In reality, the researcher is deeply interested in the meaning-making and interpretation processes that evolve from the research (Smith et al., 1999, 2009). Though all necessary procedures to ensure the researcher ‘bracket’ off preconceived notions of the area under investigation, this was not entirely possible. The challenge was that the research process involved a hybrid domain where inductive, generative, and deductive approaches
defined the interpretation adopted to enable a fuller understanding of the narratives of these young women while generating critical interpretations. Consequently, it was essential to recognise, acknowledge and make transparent the fundamental assumptions that informed the decision to conduct this research and to keenly discover and outline their influence on the investigation through reflexive practices. These reflexive processes integrated during this thesis's data collection, analysis and write-up methods acknowledge my individuality and influence on the project. Therefore, writing this position as the researcher is through the first-person pronoun ‘I’.

1.2 Acknowledgement of My Role and Position as a Researcher

Under the hermeneutic practice in I, it was vital for me as a researcher to consider what I brought to the research project through my history, experiences, and implicit and explicit assumptions I held at the start and throughout the research project (Smith et al., 2009). I am a Ghanaian, born in a rural community called Boadua in Ghana. My background is low-income, with parents who dropped out of primary education.

Although I had the opportunity to go to a low-cost private school, after a storm ripped off the roof of the public school in my village, I experienced no formal guidance and counselling throughout my primary and secondary education. I made the majority of my educational decisions, such as pathway, school, and course, without adequate information and examples to support my decision; in particular, my village did not have a strong interest in education, especially the education of girls and women.

Through my professional and educational background in psychology and education as a teacher and adolescent counsellor, I was aware of society’s beliefs and perceptions that influence young women’s experiences. My values for social justice and equity and my experiences defined why I began this project with a positive outlook on young women’s agency, values, and capability. I came to this research with limited assumptions about these young women and how they came to their STEM-related TVET decisions. Therefore, as I met and engaged with these young women, I developed preliminary assumptions. These young women confidently began to explicate the positive developments achieved as STEM-related TVET learners, regardless of the negative social beliefs surrounding their choices.

The idea that being a young woman studying STEM-related TVET courses might positively affect a young woman’s development was something I considered. However, I did not consciously know how these positive changes could take shape and how young women would interpret their positive experiences. For this reason, right from the onset, I decided to deviate from using a deficit model to frame the larger project. I chose to study young women
who had chosen STEM-related TVET courses instead of those who had not chosen these courses.

It was an opportunity for me, as a researcher, to come to the level of these young women who were now going to take me through their lives to help me understand how they were developing as young women in STEM-related TVET courses. It was a learning process for me to examine the data and experiences of these young women according to their notion of positive development and as non-conformists who were challenging the status quo in their capacity as change agents. In line with a hermeneutic circle of doing IPA, I considered the challenges these young women faced right from their announcement of their intention to study STEM-related TVET courses to their actual experiences in school as STEM-related TVET learners and sometimes beyond school. I knew these young women's experiences could not be linear, especially when they were minorities in a low-income country. Therefore, the nuances and complications came to the fore. Despite these challenges, these young women taught me how being a non-conformist can bring about positive developments and a sense of self-efficacy, despite the unique challenges faced.

Although I have a background in both quantitative and qualitative research methods, I needed to access additional training in IPA to expand particular knowledge and skills. Thus, I initially did not understand how to use an interpretative/hermeneutic phenomenology research paradigm. After extensive reading, I gradually understood phenomenological philosophy. I trusted that this approach was appropriate to design a type of research where these young women could make subjective interpretations of their lives and equally make sense of their life world. An approach of this kind was more important than simply asking young women to make self-reports of their experiences without them actively interpreting their stories before I, as a researcher, made meaning from their interpretations.

1.3 Structure of the Thesis

This chapter has provided an overview of why the current research was necessary and the fundamentals of the methodological approach employed to achieve the research aims. The thesis is in six further chapters. Chapter 2 consists of two primary elements, the literature review, and the theoretical framework. Chapter 3 provides an overview of Ghana’s TVET system and Ghana’s TVET policy context. Chapter 4 explains and justifies the two qualitative research methods, including the philosophical foundations and assumptions, the description of participants, the design processes, and the data-generation strategies that the research findings presented in Chapters 5. Chapter 5 brings the reader an IPA insight into the life world of young women studying STEM-related TVET courses in Ghana. The chapter delves
into five superordinate themes from the data generated and co-constructed with these young women. Each superordinate theme has further sub-themes that provide the needed explanations to help the reader navigate this journey with the young women.

Chapter 6 discusses the overall contributions of critical findings and concludes with a discussion of the implication of the research focusing on theoretical concepts of the leading research model, the expectancy-value model, and implications for the field and future research.

The next chapter is the literature review and the theoretical chapter. The literature review discusses the historical trajectory of TVET for development worldwide, particularly in Africa. The section then elaborates on the emerging debates concerning the underrepresentation of females in STEM education in academic and TVET pathways. The other main section introduces and discusses the theoretical and conceptual frameworks that guided the processes to achieve the primary objectives of this research project.

**Figure 1.1:** Summary of Primary Findings

Source: Author
Chapter 2. Literature Review

The literature review chapter aims to outline relevant research concerning TVET for development and to situate the relevance of investigating the participation of young women in STEM-related TVET courses. The chapter further aims to show previous studies, their limitations, and how findings from the current research can augment the existing body of research. There is significant research on TVET for the development and young women’s participation in STEM education, especially at the tertiary level. Further knowledge is also available about the experiences and identities of young women studying STEM in general academic courses. However, little research examines young women learning STEM in TVET pathways, especially at the upper secondary school level in sub-Saharan Africa. Therefore, this literature review draws on several bodies of research, concepts, and theories to highlight our understanding of the under-participation of young women in STEM-related TVET courses. It situates the problem within the emerging discourse of TVET for human development based on the critical capabilities approach to VET (McGrath et al., 2020). It also explores themes such as TVET for development, the under-participation of young women in STEM, STEM identity and education, and career decision-making. The chapter discusses the theoretical and conceptual frameworks employed to understand the decision-making processes and lived experiences of the young women studied.

The literature review process draws on the general critical discourse model (Mullet, 2018) used for the CDA analysis discussed in the analysis section. The analysis section provides details about the model. Seven processes of the general critical discourse model guided the CDA review. The initial process involved selecting peer-reviewed articles, reports, PhD theses, news articles and policy documents relevant to the investigated discourses. Sources were neither included nor excluded based on date, given that the dated articles cited remain significant in the field.

Given that research investigating the under-participation of young women in STEM has hardly evolved over the years, it was relevant to draw on all appropriate sources while ensuring the quality of these sources. The categorisation of documents was according to relevant themes based on each document's contribution to the discourses that form this chapter's sections. Figure 2.1 shows the conceptualisation tree for the literature review.
Figure 2.1: Literature Review Map

1. TVET for Development
   1.1 TVET definition and provision
   1.2 TVET is for development, especially developing countries. Why is that the case? Example of developed countries that have developed through TVET.
   1.3 TVET is a potential solution but not the panacea of all development problems

2. Incapacitated TVET
   2.1 Discuss the concern of TVET in delivering its mandate
   2.2 Low Employer Participation
   2.3 Inadequate research on specific issues such as the under-participation of young women in STEM-related TVET
   2.4 Under-participation of young women in STEM-TVET

3. TVET and career aspirations of young women
   3.1 Identify existing young women in STEM
   3.2 Discuss the identification of young women in STEM
   3.3 Question 1: a shift from the barrier discourse to an agency of young women
   3.4 Biological perspective
   3.5 Social policy and structural issues

4. Nonparticipation of girls and women in TVET
   4.1 Theorising the nonparticipation of girls and women in TVET

5. STEM education and career aspirations of young women
   5.1 Subjective values, subjective task values/evaluations
   5.2 Social-cultural constraints
   5.3 Socialisation and choice
   5.4 Work values
   5.5 A shift approach

6. Summary

6.1 Summary

6.2 Conclusions
2.1 TVET Development in Africa

The first section of the literature review provides an understanding of TVET for development. It provides an overview of TVET given the increased global interest and its revitalisation in alignment with how TVET for development in the Global South. There is a discussion of the core arguments and conceptualisation in more depth.

TVET has both an educational and a professional function and is considered a critical approach to development; however, compared to general education, TVET has experienced criticism into disrepute. Early research emphasised that TVET was not the solution to many problems faced by Global South countries (Foster, 1966; Psacharopoulos, 1988). For example, Foster’s early research in Ghana studied TVET aspirations, costs and participation in the Global South to show a mismatch between the advancement of TVET and development (King, 1993; Lauglo, 2010). These pieces of evidence inform global developmental agencies, especially the World Bank, which withdrew its policy and financial support for TVET in low-income countries in the Global South (Ngcwangu, 2015). However, criticism of these early works highlighted that pre-existing social, cultural, political and contextual issues, including inequalities, constrain this research from making factual assertions about TVET in the developing world (King & Palmer, 2007). Is vocational education truly a fallacy? The core challenge is that most of these studies and policies explored the economic outcomes of TVET while failing to address the non-economic consequences, such as how young people who choose TVET can expand their capabilities and how TVET can be made inclusive for all citizens.

In recent decades, much research has shown a renewed interest in TVET (Alhasan & Tyabo, 2013; McGrath, 2012a, 2012b; Ngcwangu, 2019; Oketch, 2007). The literature on TVET for development has provided a practical understanding of how TVET can address socio-economic issues such as youth unemployment and inequalities in developing countries, especially in Africa. However, there has been ongoing neglect of the capability approach to studying women in STEM-related TVET courses. The capability literature has failed to highlight the positive impacts that young women can derive from participating in STEM-related TVET courses. The effects of studying STEM-related TVET courses on young women’s flourishing, achievement-related decisions, attitude towards life, and developing identities, aspirations and transitions are underexplored. Also overlooked in the literature is the interaction between studying STEM-related TVET courses for young women, who are minorities in general education globally, and cultural and social structures. The following section discusses a review of the renewed proposal of TVET for development, the theories
that drive this agenda, and the positive and negative impact of these conceptualisations on the participation of young women in STEM-related TVET courses.

2.1.1 Revitalisation of TVET

The renaissance period of TVET emphasises measures to eliminate the challenges of TVET for social and economic benefits. The Incheon Declaration, the Shanghai Consensus, and the UNESCO TVET Strategies (2010–2015) have contributed significantly. These essential strategic conventions shaped the purpose and activities of the revitalisation period. The Incheon Convention engendered discussions that restructured approaches and strategies for skills development. The Shanghai Consensus then initiated debates on the appropriate methods to better position TVET to meet 21st-century skills demands (UNESCO-UNEVOC, 2013). The Incheon Declaration further described TVET as a form of education for lifelong learning and a second chance for marginalised youth and adults (UNESCO, 2015). Briefly, on the role of the Shanghai Consensus, the outcomes of Congress outlined seven critical themes for the trajectory of the revitalisation of TVET globally. The ideas are enhancing the relevance of TVET; expanding access and improving quality and equity; adapting qualifications and developing pathways; improving the evidence base; strengthening governance and expanding partnerships; increasing investment in TVET and diversifying financing; and lastly, advocating for TVET (UNESCO-UNEVOC, 2013). The theme of immediate relevance to the context of this research is the expansion of partnerships, including local and international collaborations and partnerships between TVET institutions, employers (public and private), policymakers and other stakeholders.

The literature shows that renewed local, and international TVET reforms and commitment to TVET justify the revitalisation period (Okoye & Chijioke, 2013; Tripney & Hombrados, 2013). Through new initiatives and approaches, valuable solutions continue to emerge for skills development (William et al., 2011). However, critics of macro-level international collaborations suggest that international collaborations may not adequately address national contextual challenges to TVET because of independent social and economic structures that underpin skills development (Bosch, 2017; Chankseliani et al., 2017). The recommendation is for countries to partner with local stakeholders of TVET, including employers (private and public), to contextualise and deliver skills development strategies. Remington (2018) emphasises that domestic partnerships between TVET institutions, industries and governments are likely to succeed. The outcomes of some of the revitalisation initiatives support the need for quality skills development to be demand-driven and for more employers to participate in TVET, especially in developing countries (Darvas & Palmer,
Previous studies on the participation of employers in TVET, mainly work-based learning, dual apprenticeship schemes and funding initiatives, have shown how best TVET can align with all sectors to address systemic problems (Chankseliani et al., 2017; Field, 2019; Keep, 2012).

TVET continues to gain attention globally in both policy and practice. The re-emergence of TVET as a critical developmental tool for developing countries has become a dominant narrative in most policies for the developing world from global developmental agencies such as the World Bank, United Nations Economic and Scientific and Cultural Organization (UNESCO), UNESCO International Centre for Technical and Vocational Education and Training (UNESCO-UNEVOC), the Organisation for Economic Co-operation and Development (OECD) and the International Labour Organization (ILO). However, TVET does not have a universal definition, a general definition proposed by UNESCO at the Korean Congress in 1999. Here, TVET was defined as follows:

Those aspects of the educational process involve, in addition to general education, the study of technologies and related sciences and the acquisition of practical skills, attitudes, understanding and knowledge relating to occupants in various sectors of economic and social life. (Maclean & Lai, 2011, p. 3)

As TVET continues to evolve to meet the problems it is presumed to address, other scholars have provided more specific definitions of TVET. For example, the Conflict and Education Research Group (CERG) have proposed a holistic working definition of TVET in the post-conflict setting:

A learning system in which both “soft” and “hard” skills are developed within a “joined-up”, integrated development and delivery framework that seeks to improve livelihoods, promote inclusion into the world of work, and that support community and individual agency. (Johnson et al., 2007, p. 2)

TVET has several working definitions and description terms; these include vocational education, vocational education and training (VET), career and technical education (CTE) and technical/vocational education (Maclean & Lai, 2011). These definitions assisted with a broader TVET conceptualisation but did not prescribe a purpose for TVET or propose a single descriptor of TVET. However, these various terms and definitions suggest that TVET appears to be technical work and vocational skills gained through education.

TVET for development, particularly in emerging economies like Ghana, has become a prominent policy agenda. The developmental agenda for TVET has brought about a renewed
local and global interest in TVET (Oketch, 2007; Tikly, 2013). For many developing countries, TVET is critical to address youth unemployment, economic growth, agricultural and rural development, human capital development, poverty reduction and national development (AU, 2007; Salonen et al., 2017; Tikly, 2013; UNESCO-UNEVOC, 2018). In contrast, Global North nations such as Germany, Switzerland and Singapore have designed robust TVET systems for their developmental trajectory; few developing countries have succeeded in this TVET agenda. One of the main concerns is that TVET for development cannot be a one-size-fits-all agenda while ignoring context-specific needs. For instance, Tikly (2013) draws on the case of TVET in Ghana and Singapore as former colonies of Britain, to show that although Singapore’s human capital approach to TVET for development has been successful, the same approach has been unsuccessful in Ghana. Therefore, the current interest in TVET for developing countries has sparked further discourse about what other methods could drive TVET in developing countries. I now explore these arguments and approaches.

2.1.2 Exploring the Complexities of Theorising TVET for Development in Africa

TVET in Africa has been linked to various development policies and agendas. The theoretical arguments underpinned TVET and development in Africa continue to evolve. A literature review shows four main theoretical perspectives: human capital, human rights, sustainable development and human development (McGrath, 2012a; McGrath et al., 2020; Powell, 2012; Powell & McGrath, 2014; Salonen et al., 2017; Von Kotze, 2008; Zancajo & Valiente, 2019).

2.1.2.1 Human Capital and TVET.

Human capital remains a dominant drive for the international and national agenda of TVET and development. The core argument of human capital theory is that TVET can provide the relevant skills for national productivity and economic growth and is, therefore, worthy of investigation (Arthur-Mensah & Alagaraja, 2013, 2018). The human capital model suggests that with perfect labour market structures and employees, training increases the individual’s production as both their income and national economic growth increase (Becker, 1964; Hanushek, 2010; Hanushek & Woessmann, 2011). Alagaraja et al. (2014) argue that three main factors underlie the interest in TVET as a leading policy strategy in addressing incomes, unemployment and economic growth: “changing economic structures fuelled by information technology and communication revolution, the rapid pace of globalisation and finally, but no less critical, the transitioning of many lesser developing countries into fast-growing, emerging nations” (Alagaraja et al., 2014, p. 266). The primary assumptions of
human capital approach to TVET target micro-level skills development for economic growth (Arthur-Mensah & Nagaraja (2018)).

However, a growing body of literature criticises human capital assumptions of TVET. The primary argument is that human capital approach to TVET for development limits the outcomes of development to economic gains and employability while neglecting the role of TVET in the development of non-economic outcomes, such as the development of capabilities for sustainable livelihood and well-being (Maclean & Lai, 2011; McGrath et al., 2020; Von Kotze, 2008; Wilson & Fien, 2004). Further, political economy scholars argue that the orthodox human capital notion that skills are for the workplace fails to serve the learning needs of learners and disregards the relevance of young people’s access to theoretical understandings that can strengthen vocational knowledge (Allais, 2012; D. Anderson, 2008). Also, evidence of growing social inequalities, such as the under-participation of young women in STEM-related TVET education and careers, is in contrast to the optimistic view that investment in human capital can match the availability of employment (Darvas & Palmer, 2014; Powell, 2012). Finally, critics of the human capital approach argue:

The typical TVET policy reforms can fail, such as national qualifications frameworks, competency-based training, work-based learning, and outcomes-based accountabilities based on the human capital approach to tackle social problems (e.g., youth unemployment and social inequalities). The concern is that without confronting the current global capitalism’s political, economic and labour market structural inequalities from the roots, TVET policies inevitably reproduce if not exacerbate the current state of affairs. (Zancajo & Valiente, 2019, pp. 581-582)

2.1.2.2 Human Rights and TVET.

The human rights-based approach to TVET is a natural outgrowth of the rights-based approach to Education for All (King, 2008). The rights-based approach to education underscores that education and training are universal human rights that citizens should access as social justice demands (McGrath, 2012b). Universal access to TVET appears to influence economic rights, gender parity and rights to equal opportunities. Central to these universal rights are the rights of girls and women (Misola, 2010). UNESCO-UNEVOC (2011, p. 4) expands the argument for the human rights approach to TVET by explaining:

There is a powerful human rights argument and a robust developmental case for achieving gender equality in education and attracting girls and women to TVET. When girls receive an education, it is more likely that their
livelihoods can improve, education becomes valuable, and civic responsibility is enhanced. In TVET particularly, girls and women remain underrepresented because traditional perceptions of appropriate roles for men and women in the workplace can remain largely unchallenged.

The rights-based approach to TVET advocates that TVET should be inclusive for all citizens, especially vulnerable citizens such as girls, women, and persons with disabilities. When such vulnerable citizens do not receive equal access to quality TVET or certain types of TVET, it is not an obstacle to economic growth and development but an obstruction of the fundamental human rights of these citizens.

One concern with approaching TVET from a human rights perspective is that the approach narrows the aim of TVET to increase the participation of disadvantaged citizens, such as girls, as a means of improving equality in access and gender parity. Increasing access is indeed the door to gender parity and equality. However, addressing access alone is not enough. Thus, an overemphasis on access could drive an unfortunate obstruction from other aspects of the problem, such as quality TVET and the under-participation of young women in STEM-related TVET programmes. Noticeably, there is an overemphasis on gender parity through the discourses used in TVET policy. For instance, throughout the literature, it is common to see descriptors such as ‘traditionally male-dominated programmes’ and ‘male-dominated courses’ used to describe STEM-related TVET courses. Such descriptions aim to show the gender divide in STEM-related TVET fields (see Bannikova & Kemmet, 2019; Bannikova et al., 2018; Buehren & Salisbury, 2017; Misola, 2010).

Nevertheless, some scholars argue that using these descriptors is unfortunate and does not contribute to the transformational role of TVET for girls and women (Atsu & Lartey, 2018; Morgan, 2013). The concern is that focusing on increasing gender parity and access in TVET from a human rights-based approach can potentially lead to neglecting issues such as retention, transitions, and the holistic flourishing of the vulnerable in TVET. Overall, the social justice purposes of the human rights-based approach to TVET, such as inclusivity, cannot be attained.

2.1.2.3 Sustainable Development and TVET.

Central to sustainable development and TVET are arguments for sustainable livelihoods, sustainable TVET and sustainable development processes (Palmer, 2009b; Rempatsiou, 2017; Wilson & Fien, 2004). Scholars believe TVET systems can contribute to achieving core components of the United Nations’ Sustainable Development Goals (SDGs) for the Sustainable Development Goals of countries. Drawing on the need to prioritise
sustainability over profit and productivism plans, some researchers have begun to delineate the consequences of designing TVET policies and systems that focus on a narrow understanding of the development of national productivity, economic gains and global competitiveness (Wilson & Fien, 2004).

TVET can underpin sustainable development assumptions through a complex and distinctive character. The understanding is that directly and indirectly, TVET produces and consumes resources and affects future workers’ attitudes towards sustainability. As both a consumer and a producer of resources, or more accurately, a sector involved in the transformation of resources, TVET has multiple concerns regarding sustainability. The over-exploitation of natural resources, ill-health and poverty, can threaten the ability of future generations to satisfy their needs and wants. Wilson and Fien (2004) state:

The challenge for TVET is to re-orient and re-direct its curricula to imbue students and trainees with respect for the conservation and sustainable use of resources, social equity, and appropriate development and promote competencies to practise sustainable tasks at the workplaces of today and tomorrow. (Wilson & Fien, 2004, p. 284)

The articulation of sustainable development ideas within the broad TVET policy agenda has yet to fully configure TVET for sustainable livelihoods, production, and development. For instance, TVET graduates are highly likely to be employed in precarious jobs. For most graduates, the delay in creating decent and productive work through a connection between the formal and informal environment in most African countries with larger informal economies harshly impacts the potential for sustainable development through TVET. Also, Palmer (2009b) analysed several sustainability dimensions of technical and vocational skills development in Ghana and found that sustainable intentions did not underpin Ghana’s TVET system and policies.

2.1.2.4 Human Development and TVET.

TVET for human development arguments closely aligns with the rights-based and sustainability-based arguments of TVET for development. Critics of the human capital approach to TVET for development argue in favour of the human development and capability approach to TVET. Central to this approach is a focus on the development of the learner; this is of particular relevance to young women in STEM-related TVET fields (Aikman & Robinson-Pant, 2016; Allais, 2012; McGrath, 2012; McGrath et al., 2019; Pantea, 2019; Roy et al., 2021; Tikly, 2013a). Lopez-Fogues (2016) criticises the human capital approach to TVET. He emphasises that in poorer countries where the working poor account for a
significant number of the working population and where youth unemployment is high, the use of TVET as an economic strategy must consider the freedoms of the poorest citizens (Lopez-Fogues, 2016). However, there is a need to move beyond economic perspectives in education and instrumental objectives of human capital to present a reconceptualisation of capabilities, agency and freedoms to define the purpose of TVET to achieve more than economic goals (Lopez-Fogues, 2016).

Drawing on seminal works on human development, social justice and capabilities by Sen (1999, 2009) and Nussbaum (2000), critics of the human capital approach to TVET argue for TVET policies that do not narrow the focus of development to human capital and economic outcomes. These scholars propose a critical-capability approach (CCA) to TVET. The assumption of the CCA is to expand the TVET for development agenda to include the ‘agencies and freedom’ of VET learners. Such agencies and freedoms prioritise TVET learners’ voices and are based on the concept that personal flourishing is crucial to economic productivity and competitiveness (McGrath, 2012b; McGrath et al., 2020; Powell, 2012; Powell & McGrath, 2014; Tikly, 2013). Zancajo and Valiente (2019, p. 582) add that a new transformative role of TVET under the CCT-VET framework is for TVET policies “to expand learners' freedom to pursue their life projects.” For example, in a study to examine aspirations, agency and well-being among young women in technical and vocational schools in rural Tanzania, DeJaeghere (2016, p. 250) conceptualises her work within the capability approach. She argues that “using a capability approach to analyse young women's educational and livelihood aspirations allows us to analyse what they value for themselves and others over time.” Watson and Jeffrey (2007, p. 25) add that “to increase the diversity in STEM education, policymakers and scholars need to acknowledge the complex interactions among the development of self-identity, cognitive capabilities, and occupational choice”. The following section deliberates on challenges that hinder TVET.

### 2.2 Incapacitated TVET: Challenges to Skills Development

Various TVET of development theoretical assumptions present TVET as a solution to pressing global concerns, such as youth unemployment and poverty (Brown et al., 2011; Grubb & Lazerson, 2009). However, this solution has not been actualised globally. The functional TVET systems in countries such as Germany, Denmark, Switzerland and New Zealand have given significant support to the argument that TVET has the potential to reduce unemployment through skills development (Beicht & Walden, 2017; Chankseliani et al., 2017). However, TVET has not achieved such strides in other parts of the world, especially in sub-Saharan Africa. There are numerous challenges to TVET in this region, such as the poor
perception of TVET, the limited participation of women and girls, inadequate incentives, low employer participation, curricular inadequacies and underfunding, a lack of research in TVET, multiple standards of quality TVET systems and limited data sources for global research (Arthur-Mensah & Alagaraja, 2013; Oketch et al., 2009; Renaud, 2009).

### 2.2.1 Low Employer Participation

Global trends show that most industries in developing countries are not investing heavily in TVET (Schaack, 2009). In a comparative study, Chankseliani et al. (2017) found that industries in Germany, Australia, Denmark, and New Zealand engaged in skills development, while industries in countries such as South Africa, Egypt and India had low skills development engagements. The authors acknowledge the difficulty of accessing data from most countries and fail to have a representative sample. The countries they compared were mostly OECD countries; there was no sub-Saharan African country. In another study, Okae-Adjei (2017) interviewed employers about their perception of polytechnic graduates in Ghana. His findings show that employers had a negative impression of TVET graduates. Perhaps, employers’ negative attitudes towards TVET graduates could be a reason for their low participation in skills development via school-based TVET. Okae-Adjei’s research could be enlightening if he probed further to know how employers engaged with TVET institutions.

Even though this was not the focus of the study, such findings could inform future researchers and stakeholders. In a TVET needs assessment report on Ghana, Wojcichowsky (2016, p. 5) states:

> The industry does not appear to have confidence in the existing school-based TVET system and has resorted to expensive in-house training. For instance, companies have been able to sponsor joint training programs among their workforces. These may have been successful for immediate needs but is not sustainable long-term solution.

Other research shows that two main reasons for industries' low participation in TVET are the poaching of workers by other companies in the same sector and a lack of incentives for employers (Alagaraja et al., 2014; Webster & Sausner, 2017). These concerns would not be reasons for low employer engagement in TVET if employers considered the long-term benefits of engagement in the development of school-based TVET (Darvas & Palmer, 2014; Mann, Kashefpakdel et al., 2018). The long-term benefits of employers’ engagement in school-based TVET, such as cost-effective recruitment strategies and a skilled labour force, are some reasons employers’ engagement in school-based TVET is non-negotiable (Remington, 2018; Schaack, 2009). Therefore, as Dunbar (2013) explains, employers may
not be engaging in TVET because they are either unaware of or are not considering the long-term benefits of their engagement in TVET. In their report on Ghana, Darvas and Palmer (2014, p. 23) emphasise that “there is often an imbalance about the benefits of and returns to learning, which can result in underinvestment in skills, especially by employers.”

2.2.2 Limited Research

The global challenges to TVET include but are not limited to paucity of research, inadequate measurement of quality TVET systems and lack of significant data sources from specific countries, predominantly low-income countries. This section focuses on insufficient TVET research as a global challenge to TVET. There is little TVET literature and data available, especially from Ghana. Bilateral organisations and scientific communities are encouraging more research in TVET because TVET research is relevant for quality skills development (Oketch et al., 2009; Wittig et al., 2009). Findings from other TVET research can provide recommendations and practical solutions to the national challenges of TVET and facilitate policy formulation and implementation. The heterogeneity of TVET systems is one of the hindrances to comparative studies (Chankseliani et al., 2017; Rauner, 2009). This conclusion reveals the complexities of skills development, the differences in labour market demands, and the need for context-specific research to develop insight into skills development. Therefore, the findings of this current research will contribute immensely to the existing literature and will further add to comparative and international studies of TVET.

2.2.3 Under-Participation of Girls and Women in STEM-Related TVET

Researchers have drawn on different theories and perspectives, including human capital theory, feminism, human rights, social justice and social inclusion, to underscore the pertinence of improving the participation of females in STEM education (Blickenstaff, 2005). For example, Bøe et al. (2011) maintain that everybody should have the freedom, not only a formal, free education choice, including young women choosing STEM education. One prominent perspective is that gender equality in STEM education is necessary to achieve the United Nation’s SDGs (Anyang, 2018; Patterson, 2017). Ball et al. (2017) add that there is an increase in the demand for the diversity and intellectual capabilities that women bring to STEM careers. Therefore, it is essential to harness girls’ STEM aspirations so that they can pursue STEM careers. For others, the high economic value of STEM careers, the global competitiveness in STEM fields and the increasing availability of STEM jobs in the labour market are fundamental reasons why girls should be encouraged to take up STEM courses (Dasgupta & Stout, 2014; Hill et al., 2010; Wang, 2013). The digital and technological revolution makes it critical to increase the number of females accessing STEM education.
Another argument is that the underrepresentation of females in STEM education is a ‘leaky pipeline’, where females drip out of STEM educational pathways (Blickenstaff, 2005; Petray et al., 2019). These assertions bolster the urgent need to develop sustainable approaches to increasing female participation in STEM education. The reported arguments have engendered three central debates in the literature explaining the underrepresentation of females in STEM education: biological differences, individual attributes and sociocultural debates (Brotman & Moore, 2008; Hill et al., 2010; Wang & Degol, 2013).

2.3.1 Biological Perspective.

Primarily, advocates of explanations based on biological differences hypothesise that biological elements, including hormones, brain type and cognitive ability, justify the underrepresentation of females in STEM education (Penner, 2008). For instance, Benbow and Stanley (1980) reported that gifted females had significantly lower mathematical reasoning abilities among gifted students than talented males. Likewise, Maeda and Yoon (2013) stated that females’ lack of 3-D mental rotational knowledge made pursuing STEM disciplines such as engineering demanding for young women. Geary (1998) argued that evolutionary differences in brain functioning and cognitive ability disadvantage females in general intelligence, arithmetical and algebraic word problems and geometry compared to males. From a cerebral differences viewpoint, Baron-Cohen (2003) explained that an empathising brain type debilitated females from pursuing STEM, while a systemising brain type facilitated males pursuing STEM. Moreover, Kimura (1992) found that hormonal differences like testosterone levels caused males to be superior in mathematics.

The biological difference debate makes simplistic associations between human biological components, including chemical compositions, brain functions and brain types, and outcomes like intelligence and cognitive abilities. These associations are not causations and cannot conclude that females are incapable of pursuing STEM education. Hence, the debate concerning biological differences, especially the cognitive inability of females, remains contested (Spaull & Makaluza, 2019; Wang & Degol, 2013). For example, Stoet and Geary (2018) analysed the data of 472,242 students in the Programme for International Student Assessment (PISA). They found that females performed equally to, if not better, than boys in mathematics and science, but few females capable of college-level STEM had enrolled in STEM courses. Recently, McDool and Morris (2020) found that prior academic attainment in science and mathematics played a minor role in the STEM gender gap in vocational and general qualifications.
2.3.2 Individual Perspective.

Consequently, Riegle-Crumb et al. (2012) propose that an alternative lens, such as the social milieu, could better answer the gender–education paradox in STEM. An alternative lens employed in the literature is the individual attributes debate, where research investigates issues including self-confidence, attitudes, identities, and interests (primarily psychological constructs about the ‘self’). Supporters argue that females’ perceptions about the ‘self’ underpin their decision not to pursue STEM. For example, Valenti et al. (2016), from an attitudinal and interest perspective, found that female adolescents implicitly considered science less creative and formed more negative attitudes toward science than male adolescents. Concerning self-efficacy and self-identity, Hughes and Roberts (2019) found that females with greater openness to challenge (a subcomponent of self-efficacy) had a higher STEM identity. Again, Tellhed et al. (2016) found that interest in STEM majors was strongly related to females’ self-efficacy for STEM careers and, to a lesser degree, to females’ social belongingness. However, research from the individual attributes perspective overemphasises individual attributes while failing to consider socio-cultural factors that influence these individual attributes.

2.2.3.3 Social Perspective.

Other research engages a socio-cultural viewpoint to highlight that gendered socialisation, cultural stereotypes, and environmental factors reinforce the underrepresentation of females in STEM education (Petersen & Hyde, 2014b; Reinking & Martin, 2018). The prominent argument is that traditional gender stereotypes for STEM education strengthen the notion that STEM education is masculine (Buday et al., 2012; Cheryan, 2012; Zecharia et al., 2014). For example, Makarova et al. (2019) found that female adolescents in Swiss secondary schools firmly attributed masculinity to maths, physics and chemistry. Moreover, advocates of the socio-cultural perspective report that sex-role socialisation, especially the perception that females are carers and value collective goals, impedes female interest in STEM education and careers (Diekman et al., 2010; Petersen & Hyde, 2014a). While the socio-cultural perspective is context-dependent, the evidence suggests that societies maintain the categorisation of STEM education as a domain for males and not females.

In addition to the individual attributes and socio-cultural debate, other studies explain that significant actors (parents, teachers, siblings, and peers) within society (family and school) promote the discussed negative self-attributes and socio-cultural stereotypes. For instance, Koch et al. (2019) found that positive parental support was critical in STEM
persistence and career plans among African American and Latina female adolescents. Further, Brown and Leaper (2010) found that Latina and European American female adolescents who experienced academic sexism felt less competent in mathematics and science. In Ghana, Agbley (2015) found that negative perceptions of significant adults like fathers and brothers in a patriarchal society discouraged females from choosing science in TVET secondary schools because female adolescents have to conform to social and cultural norms. The finding suggests that significant social actors remain essential factors affecting the STEM educational choices of females.

Recommendations from these research traditions have become grounds for interventions to increase the representation of females in STEM education. It is noticeable that such interventions mediate issues concerning negative stereotypes, negative social perceptions, the STEM curriculum and adverse school environments (Leaper & Brown, 2014; Liben & Coyle, 2014; Nam et al., 2016; van den Hurk et al., 2019). For example, an informal science intervention, the Science Program to Inspire Creativity and Excellence (SPICE), in the USA, based on theories of identity formation and self-efficacy, improved the science affinities (interest, efficacy, attitudes and identities) of young women participants compared to a control group (Todd & Zvoch, 2019).

Another intervention called CASE (Changing Alaska Science Education) paired female scientists with class teachers in a formal education context as role models. The results showed that the intervention significantly changed students’ scientific interest in and perceptions of female scientists and led to better science engagement – but not an increase in science participation (Conner & Danielson, 2016). ASPIRES and ASPIRES 2 are the UK’s Economic and Social Research Council projects that explored science aspirations and engagement among 10–14-year-olds and 14–19-year-olds, respectively (Francis et al., 2017). Archer et al. (2015) used data from ASPIRE to investigate why Black students are less likely to have science aspirations. Using the case study of two black girls who defied the trend and aspired toward science careers, the authors found that the enjoyment of school science, academic orientation and science motivation defined Black girls’ ability to aspire and sustain their science aspirations (Archer et al., 2015). In Israel, an intervention was arranged for students to visit a high-tech company to meet female scientists as role models. The intervention improved respect for female scientists as intelligent and creative persons; however, it did not change students’ science interests and STEM career choices (Bamberger, 2014).
Furthermore, in Ghana, the government, development partners and NGOs continue to initiate interventions and policies to increase female participation in STEM. The Women in Technical Education Department (WITED) is an example of a Ghanaian government policy initiative. The department supports young women in technical education through scholarships and links them with women in male-dominated technical fields for mentorship and guidance (Wojcichowsky, 2016). The Ghana Internship and Mentoring Programme by the Millennium Development Authority (MiDA) is a recent intervention. The initiative’s objective is to support females pursuing STEM-TVET programmes in obtaining practical skills relevant to the power sector (Ministry of Gender, Children and Protection Social, 2018). The concern is that research on the impact of these interventions is weak and inconsistent; hence, there is no authoritative confirmation of which interventions are effective. Further, scholars like Lykkegaard and Ulriksen (2019) and Watson and Jeffrey (2007) argue that the leaky pipeline image, for instance, is a misleading metaphor and interventions based on the metaphor are inadequate.

2.3 Conceptualising Young Women’s STEM Identity and Formation: Typicality and Stereotypes

Generally, researchers use identity as a conceptual tool to understand individual and group sameness and differences. The works of William James, Erick Erickson, Dan McAdams and George Herbert Mead underpin the modern conceptualisations of identity (Hammack, 2015). The issue of sameness and difference draws on the lines of a personal sense of belonging, social categorisation, and the identification of people as they transition through life. Research in this area cuts across multiple disciplines, but psychology and sociology dominate. Scholars within these two fields have extensively applied the concept of identity to educational issues. For instance, subjects studied include identity among teachers, learners’ vocational identity and STEM identity.

Research reviews on young women’s STEM identity (Dunlap & Barth, 2019; Kim et al., 2018; Morton & Parsons, 2018; van Veelen et al., 2019) have revealed that most research follows prescriptive definitions and preconceptions of STEM identity. Most of the literature has focused on how STEM membership is relevant to young people, which Starr (2018) describes as typicality. Hence, the literature aligns with STEM identity and social categorisations such as gender, class and race (Kim et al., 2018). The limitation of existing research is the STEM identification processes, which Starr (2018) refers to as centrality. Often, scholars have questioned why young women do not self-identify as ‘STEMist,’ with
less focus on how they develop STEM identities as an essential component of their actual or ideal selves.

The existing literature has further failed to investigate and understand the identities that form part of young women’s STEM identity. Considerable research has focused on young women’s STEM identities in college and university, with minimal focus on developing STEM identities in the formative years of secondary education. While tertiary education is a significant life transition that most young women go through, other significant periods include the transition from lower secondary to upper secondary, which merits equal attention. Although upper secondary education is a crucial transitional period where subject and pathway selections begin, there is a lack of research into young women’s STEM identity at this level. Typical studies concentrate on young women’s STEM identity as undergraduate STEM students (Hazari et al., 2013; Seyranian et al., 2018). The narrowed focus on the typicality of young women’s STEM identity has led to considerable research on the divided sense of whether or not young women feel a sense of belonging in STEM. The studies of young women’s STEM identities can be categorised into three central stereotypes. The three main stereotypical discourses that dominate the study of young women’s STEM identity are the socio-cultural stereotype, the STEM environment stereotype, and the STEM-ability stereotype. Parents influence these socialised identities, peers, external experiences and other socialisers (Bøe et al., 2011; Mujtaba et al., 2018; Peteranetz et al., 2018).

2.3.1 Socio-cultural Stereotype

A significant amount of STEM identity research has focused on the socio-cultural dynamics of STEM identity. Most of this research has focused on how the social construct of gender shapes STEM identity among young people. Discursive representations of STEM generally fuel the gendered conceptualisation of STEM as masculine (Barford & Coombe, 2019; McDool & Morris, 2020; Petersen & Hyde, 2014a). The stereotypical dichotomy between masculinity and femininity underpins the gendered prescription of STEM in TVET (Steinke, 2017; van Veelen et al., 2019). The social design of STEM as a masculine field has created an incongruence of identity for young women socially categorised as feminine. Therefore, scholars like van Veelen et al. (2019) and van der Vleuten et al. (2018) have described gendered STEM identity as the normative domain of STEM identity. From a social identity threat perspective, van Veelen and colleagues argue that STEM education and the masculine work identity threaten young women’s sense of STEM identity. The gendered account of STEM education and work as masculine does not provide a realistic understanding of how young women categorised as females and feminine can form a STEM identity. The
gendered stereotype overlooks other potential salient identities, such as vocational and performance identities, which can help young women create STEM identities. Research has shown that when STEM capabilities or efficacy underpin young women’s STEM identity, gender identity threat becomes an insignificant threat. As van Veelen et al. state:

Given that women who opt for a STEM career have proven their competence, motivation, and perseverance in STEM, one could argue that they have effectively developed strategies to cope with gender identity threats or are resilient to them altogether. (2019, p. 3)

Despite sufficient evidence that young women can study STEM-related TVET courses, gendered STEM identity remains a threat to young women’s participation in STEM-related TVET courses because the socialisation of masculinity and femininity remains dominant in most cultural worlds (Whitehead, 1996). These categorised cultural worlds constrain young women from perceiving themselves as fit for STEM, creating the incongruence between being a female and studying a masculine course such as STEM-related TVET courses. The result is an identity crisis, even for young women who choose STEM-related TVET courses.

Another perspective related to the socio-cultural stereotype is gender role differentiation. The gender role differentiation perspective is related to assigning specific social roles associated with STEM and gender. Again, masculinity or femininity defined these gender roles (Teig & Susskind, 2008). The key argument is that STEM is typically seen as male since it is associated with social isolation and a high level of independence (Cheryan et al., 2015; Kerkhoven et al., 2016; Master & Meltzoff, 2016). It follows that young women cannot create an association with STEM courses or careers since they are socialised to be carers, dependent and socially committed. The concern is that young women use these stereotypes as tools in defining STEM identity and use them to explain why they are not fit to choose STEM careers. Haasler and Gottschall (2015) used the case of the German vocational system to argue that persistent gender discrimination in TVET, which prescribes career preference for young people, is attributed to work-based socialisation, which deepens work biases. The work-based categorisation defines individuals as having a particular set of vocational skills and qualifications that fit the forms of work-based socialisation, which functions as an identification structure. For instance, in response to an argument that British girls’ subject choices and career aspirations had changed and become more diversified, Francis et al. (2003) studied girls in mixed and single-sex secondary schools in England to investigate this matter. They found that STEM subjects such as physics, chemistry, and biology were the favourite subjects of slightly fewer girls compared to other subjects such as
health studies, music, and religious studies. Table 2.1 and Figure 2.2 show the subject preference of girls in schools in England.

**Table 2.1: Course Preferences in Girls-Only Schools and Mixed-Gender Schools**

<table>
<thead>
<tr>
<th>Course</th>
<th>Girls’ schools %</th>
<th>Mixed schools %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Art</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>English</td>
<td>11</td>
<td>20</td>
</tr>
<tr>
<td>Maths</td>
<td>11</td>
<td>18</td>
</tr>
<tr>
<td>History</td>
<td>7</td>
<td>-</td>
</tr>
<tr>
<td>Science (biology, physics, chemistry, science)</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Drama</td>
<td>6</td>
<td>16</td>
</tr>
<tr>
<td>Geography</td>
<td>6</td>
<td>-</td>
</tr>
<tr>
<td>PE</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>IT</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Design technology</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>French</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>Music</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>Business studies</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Religious studies</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Child development</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Media studies</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Health studies</td>
<td>-</td>
<td>2</td>
</tr>
</tbody>
</table>

Less than 2% sociology, Latin

Source: Francis et al. (2003, p. 431)
Figure 2.2: Favourite and Least Favourite School Subjects among Girls

Additionally, the study found that girls preferred socially and culturally fit careers for their feminine identity compared to STEM careers. Although Table 2.1 and Figure 2.2 show that girls highly chose maths, their career aspirations did not match their subject choices. Table 2.2 showed that the occupational aspirations of British girls aged 14 to 16 were mostly in areas traditionally categorised as feminine. Most of these girls' selected jobs fit the cultural and social description of femininity as caring and nurturing; examples included medical doctors, nurses, and teachers. These girls did not select jobs with a pure STEM focus, such as engineering, except for computer-related careers.

Table 2.2: Job Preferences of Girls

<table>
<thead>
<tr>
<th>Jobs</th>
<th>Girls’ schools %</th>
<th>Mixed schools %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doctor</td>
<td>21</td>
<td>10.3</td>
</tr>
<tr>
<td>Teacher</td>
<td>20</td>
<td>9.9</td>
</tr>
<tr>
<td>Lawyer</td>
<td>13</td>
<td>6.4</td>
</tr>
<tr>
<td>Computers and IT</td>
<td>9</td>
<td>4.4</td>
</tr>
<tr>
<td>Actress/performer</td>
<td>8</td>
<td>3.9</td>
</tr>
<tr>
<td>Business</td>
<td>8</td>
<td>3.9</td>
</tr>
<tr>
<td>Media</td>
<td>7</td>
<td>3.4</td>
</tr>
<tr>
<td>Accountant</td>
<td>6</td>
<td>3.0</td>
</tr>
<tr>
<td>Journalist</td>
<td>6</td>
<td>3.0</td>
</tr>
</tbody>
</table>
The findings showed a level of diversity in career aspiration and subject preference. However, they also revealed how socially embedded, prescribed structures such as gender, social class and ethnicity influence girls’ education and career aspirations earlier in life. Cheryan et al. (2015, p. 6) summarise that those stereotypical identities constrain young women from choosing engineering and computer sciences courses:

Why are girls, even those who grew up with technology in their homes and took advanced math classes in high school, less likely than boys to pursue computer science and engineering? Our central thesis is that girls’ underrepresentation in these fields is not due to their intractable lack of interest in choosing these fields. Instead, we argue that women’s choices are constrained by societal factors, particularly their stereotypes about the kind of people, the work involved, and the values of these fields. Even if they are not accurate, these perceptions shape girls’ academic choices by communicating to them where they belong.

Although these socio-cultural identity stereotypes provide a picture of how social and cultural structures prescribe identity and a sense of belonging and fit, the current body of research overemphasises gender, race, and ethnicity (Tellhed et al., 2016). Although gender is a universal and overt form of social identity, it translates and shapes other forms of identity, as this research shows, such as work identity and belonging. Researchers must explore different social and cultural identities that prescribe stereotypical STEM identities for young women. In the context of the Global South, especially in Africa, there is a need for research into how urban and rural identity influences STEM identity among young women. Investigating rural and urban identity can involve other significant social stereotypes, such as

<table>
<thead>
<tr>
<th>Career</th>
<th>Rating</th>
<th>Points</th>
<th>Subtotal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hairdressing</td>
<td>5</td>
<td>2.5</td>
<td>2</td>
</tr>
<tr>
<td>Nursing</td>
<td>5</td>
<td>2.5</td>
<td>2</td>
</tr>
<tr>
<td>Childcare</td>
<td>5</td>
<td>2.5</td>
<td>4</td>
</tr>
<tr>
<td>Physiotherapist</td>
<td>4</td>
<td>2.0</td>
<td>0</td>
</tr>
<tr>
<td>Vet</td>
<td>4</td>
<td>2.0</td>
<td>2</td>
</tr>
<tr>
<td>Psychologist</td>
<td>4</td>
<td>2.0</td>
<td>2</td>
</tr>
<tr>
<td>Beautician</td>
<td>3</td>
<td>1.5</td>
<td>2</td>
</tr>
<tr>
<td>Nursery nurse</td>
<td>3</td>
<td>1.5</td>
<td>0</td>
</tr>
<tr>
<td>Public relations</td>
<td>3</td>
<td>1.5</td>
<td>0</td>
</tr>
</tbody>
</table>

Source: Francis et al. (2003, p. 435)
socio-economic status. There is, for instance, a paucity of research investigating how young women from rural and poor backgrounds identify with STEM.

### 2.3.2 Institutional Climate Stereotype

Another stereotype considerably explored by the literature is that of the institutional climate, such as the gender status of the school as single or co-educational (Anders et al., 2018; Cherney & Campbell, 2011). The institutional climate stereotype concerns the stereotypes associated with the spaces where it occurs. The idea of institutional climate applies as a symbol for the institutionalised environment in which young women in STEM engage. Most literature has focused on the institutional climate in schools, training, and work. The two dominant spaces where the institutional climate stereotype happens are the classroom and the workplace. The literature has shown consistent findings on how women experience STEM environments and the impact these experiences have on their outcomes. For example, a study in the USA examined how different types of sexism affected STEM identity and STEM efficacy among female undergraduate students (Kuchynka et al., 2018). The study drew on Glick and Fiske’s (1996) ambivalent sexism theory to provide a hostile and benevolent picture STEM environment. Kuchynka et al. (2018) found that, as expected, the women they studied reported experiencing benevolent sexism in protective paternalism and gender differentiation in their STEM courses and course-related activities, which were clear examples of hostile sexism. The study also found that women who experienced frequent hostile sexist environments predicted lower intentions to major in STEM subjects and were likely to receive lower GPAs in STEM courses. Finally, Cherney and Campbell (2011) found that math performance in single-sex schools was significantly higher than in co-educational schools, although males from single-sex schools outperformed girls. The overall picture is that the climate in which young women receive STEM education and training can enable or constrain their STEM education and career aspirations.

Other research has focused on environmental factors such as curricula, teaching style and the relationship between classroom structures and young women’s STEM participation and career expectations. For example, Wild (2015) studied the impact of the nature of the classroom learning environment in high school on STEM expectations and decisions. The study showed that when students perceived the environment of chemistry classes as more constructivist, these students were significantly more likely to choose physical, life and social science careers than other careers. Also, Shirazi (2017) studied different factors that can influence the STEM climate in the classroom and found that learners in lower secondary school (ages 11–14) were more likely to attribute their negative school science experience to
monotonous science curricular content. The study found that girls were three times more likely to consider a computer science course when the classroom environment did not project current computer science stereotypes than when stereotypes were evident in the classroom. However, boys were equally interested in choosing computer science regardless of the classroom environment. These pieces of research show how stereotypical classroom climates can affect girls’ participation in STEM education.

In STEM workplace research, researchers use the concept of identity threat as a social sense of belonging or not belonging to study how women create a sense of belonging at work. Social identity threat is when individuals, in this case, young women, feel that the stereotypes they face are the results of their group membership, especially in a group that is not typically for women (Spencer et al., 1999; van Veelen et al., 2019). In this case, women cannot identify themselves as belonging to the STEM work environment. The disconnect between their STEM identity and STEM in the workplace can lead to underperformance, lack of self-esteem and eventual withdrawal from STEM. Research shows that numerical and normative male dominance in STEM careers and the workplace produces the highest gender identity threat among women STEM graduates. Thus, more women report that they experience high gender identity threats when outnumbered by men in their immediate work environment. van Veelen et al. (2019) further argue that gender categorisation in normative or numeric terms increases consciousness about gender at work and intensifies the expectation that gender is a mediate value over competencies. These concerns make it highly salient to consider gender categorisation in normative or numeric terms when discussing the holistic participation of women in STEM workplaces. These circumstances make the work environment more sexist and hostile to women (Riegle-Crumb et al., 2018). According to these stereotyped identities, the streaming of careers shows a division whereby men are socially and culturally fit for engineering or computer science careers. In contrast, with their caring and nurturing tendencies, women are socially and culturally fit for health care professions (Kerkhoven et al., 2016).

**2.3.3 Ability Stereotype**

Research suggests that ability stereotypes shape and forms young women’s STEM identities. Considerable research has found that the ability stereotypes shaping the STEM identities of young women are related to societal perceptions of what STEM is academically and the kind of academic ability that is needed to participate in STEM (Schuster & Martiny, 2016; Spencer et al., 1999; Starr, 2018; Starr & Leaper, 2019; Wang et al., 2013). These academic stereotypes are based primarily on young women’s performance in mathematics.
The primary argument for this maths stereotype has been that young women experience negative attitudes, higher maths anxiety and lower maths self-concepts than young men, which impede their performance in maths (Gunderson et al., 2012). These perceptions of young women’s ability can lead to the idea that young women cannot be STEM learners and workers because there is an academic dissociation between STEM requirements and what women can learn and achieve. STEM is considered inappropriate for young women because of their perceived maths limitations. As discussed in the literature, the maths performance stereotype was a popular research plan linked to biological differences, as Kimura (1992) discussed (see the section on the participation of girls and women in STEM-related TVET pathways).

However, there are significant inconsistencies in research that have endeavoured to show the performance difference in maths between males and females. For instance, Tembon and Fort's (2008) analysis of PISA maths performance showed that boys tended to outperform girls in most countries in mathematics. Even when gender differences in mathematics performance were modest, boys were generally overrepresented among top performers, and boys and girls were equally represented among low performers. On the other hand, more recent research shows that the ability gap in mathematics has narrowed, and in some instances, young women are performing at the same level as young men in maths; in some cases, females outperform males in both maths and reading (Francis et al., 2003; Wang et al., 2013). For instance, a recent study in South Africa analysed Progress in International Reading and Literacy Study (PIRLS) and Trends in International Mathematics and Science Study (TIMSS) Southern and Eastern African Consortium for Monitoring Educational Quality (SACMEQ) and Matriculation performance data over the period 1995–2018. The study showed that girls outperform boys in all subjects and all grades, including in maths and physical science, and on the school-leaving exam, the Matric. The evidence challenged the perceived notion that males outperform females in these subjects (Spaull, 2013).

The above discussion has shown how and why young women may not have a positive STEM identity because of the perceived dissociation between the academic abilities that align and do not align with STEM. Another perspective concerning the ability stereotype is the STEM identity associated with being a nerd. The ‘nerd’ stereotype is one of the STEM identity incongruences widely recorded in the literature (Starr, 2018; Starr & Leaper, 2019). While being a STEM nerd or a nerdy genius is generally perceived to describe high levels of intelligence for males, it is associated with social awkwardness and being romantically unattractive for females. The genius stereotype affects girls’ and women’s STEM identities.
more than men’s because of a socially prescribed association between intelligence, brilliance and masculine traits (Bian et al., 2017). The reason suggested is that girls and women are socialised to value romantic partnerships, being sociable, caring for others and being attractive to others (Glick & Fiske, 1996).

Young women are socialised to embrace identities that conflict with the nerd genius. Hence, most young women consider pursuing STEM fields as non-conforming to their self-concept. Although being a genius is a positive identity and highly cherished in the STEM field, it becomes a negative identity for young women. Therefore, research has shown that because most intelligent young women can perform in maths and reading, they tend to choose courses and careers requiring reading. Although these courses and careers are for equally competent people, they do not carry the identity of nerdy genius. For instance, a study of 195 undergraduate women showed that young women endorsed stereotypes that people who work in STEM are nerdy geniuses, tech-obsessed, have no social lives and are not successful romantically (Starr, 2018). The internalisation of these socialised notions is negatively related to STEM identity and, in turn, to the motivation of young women. The nerd-genius measure was a new scale developed for this study.

The majority of the research on STEM identity research, as discussed so far, has significantly covered how and why young women do not develop STEM identities and for which they have negative self-concepts regarding STEM courses and careers. There has been significant work on social, cultural, institutional, and structural constraints on STEM identity among young women. However, the existing body of research fails to explore how participation in STEM-related TVET courses positively influences the STEM identity of young women. One limitation of the current literature is the absence of a critical discourse about how young women build STEM education and career identities that are not related to being nerds or geniuses.

2.4 Conceptualising STEM Education and Career Decision-Making Among Young People

Generally, researchers have used three broad conceptualisations to discuss education and career decisions or aspirations. Individual and subjective education and career decision-making approaches are the first and most common conceptualisations. The second conceptualisation focuses on the social and structural approach to education and career decision-making. The final theme concerns the interdependent perspective of the subjective and social approaches to education and career decisions. Scholars who approach education and career decisions from individual and personal perspectives emphasise psychological and
subjective approaches (Bottia et al., 2015; Rayner & Papakonstantinou, 2020; Santos et al., 2014).

On the one hand, scholars who argue that social and structural perspectives define education and career decisions emphasise how socially designed pathways and systems shape education and career decisions (Hodkinson & Sparkes, 1997; Olsson & Martin, 2018). The interdependent approach to education and career decisions emphasises that individual approaches to education and career are neither independent nor dependent on social and structural realities; instead, there is an interplay among individual, social and structural factors during education and career decision-making processes (Hood et al., 2012; Wang & Degol, 2013). Table 2.3 shows theories that have conceptualised the various approaches to education and career decisions.

**Table 2.3: Different Career-Development Theories**

<table>
<thead>
<tr>
<th>Groups</th>
<th>Career-development Focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trait-and-factor theories</td>
<td>What people can be shown to be like, in their abilities, attainments and personality</td>
</tr>
<tr>
<td>Self-concept theories</td>
<td>How people see themselves in terms of ability and motivation, and how concepts of self-change</td>
</tr>
<tr>
<td>Opportunity-structure theories</td>
<td>What work is on offer to people like them, in their social position</td>
</tr>
<tr>
<td>Community-interaction theories</td>
<td>Whom people attend to among the people they know, and how they use such models and feedback</td>
</tr>
<tr>
<td>Career-learning theories</td>
<td>How earlier learning lays the foundation for later influencing what people learn and do</td>
</tr>
</tbody>
</table>

Source: Law (1999, p. 36)

While scholars have tried to explore various explanations for education and career decisions, most literature overemphasises the outcomes of decision-making rather than the processes involved in education and career decisions. Therefore, the existing literature lacks a critical explanation of how individuals navigate their education and career decision-making processes. The outcome is a paucity of research that traces the decision-making process and how individual, social, and structural factors play out at each critical stage of education.

**2.4.1 The Individualised Approach to Education and Career Decision-Making**

The individualised approach to education and career decision-making focuses on the individual’s subjective attributes and characteristics that shape education and career decision-
making outcomes. One core argument is that subjective characteristics shaping education and career have focused on the psychological dispositions that drive rational decision-making. These psychological associations can be extrinsic and intrinsic motivation, intellectual ability, interests, self-determination and autonomy (Bottia et al., 2015; Kang, Hense, et al., 2019; Krapp & Prenzel, 2011; Petersen & Hyde, 2014a; Rayner & Papakonstantinou, 2020; Santos et al., 2014). For instance, a study investigating the interindividual dimensions of decision-making among eighth-grade students, Trends in International Mathematics and Science Study (TIMSS), presents a global comparison of academic motivation and achievement in the four major science domains of physics, chemistry, biology, and earth science. The study found that academic attainments in each domain depended on self-concept beliefs and value perceptions. Notably, the study found that self-concept and intrinsic and utility values are positively associated with coursework aspirations in the same field (Guo et al., 2017).

Another study investigated the relevance of motivation and personal values to undergraduate student’s decision to study engineering and reported variations among the unique psychological characteristics that define STEM career aspirations and decision-making (Matusovich et al., 2010). Thus, pursuing engineering was possible when students had a high sense of self-attainment value rather than interest. The study also confirms that one value category alone is not enough to explain persistence. Low attainment, high utility, and moderate interest can lead to a STEM career and educational goals (Kerr & Kurpius, 2004; Matusovich et al., 2010). One of the few studies on career aspirations and decisions at the lower secondary school level focused on the relationship between personal interest in science and the scientific aspirations of 401 Grade 7 students aged 13 in Finland. The study used a multi-group structural equation modelling and found that interest in science played a pivotal role in motivating students to engage in science-related endeavours, enrol in advanced science programmes and aspire to work in science-related fields (Kang, Hense, et al., 2019). Specifically, the study found that female students’ science interests correlated positively with personal time and innovation-oriented career orientation concerning future career perceptions than with outcome-oriented career expectations, which were negatively associated with female students’ science interests (Kang, Hense, et al., 2019).

The main critique of the study of an individual or intraindividual dimensional perspectives on education and career decision-making is that the individual is a complex being with external factors mediating the subjective nature of choice and agency. This makes the individual dimensions of education and career decisions simplistic, mechanistic, and minimalistic. The approach makes it seem that young people make education and career
decisions with complete autonomy and isolation from other social, structural, economic, and political systems which underlie and influence individual agency and choices.

2.4.2 The Socialised Approach to Education and Career Decision-Making

A considerable body of literature conceptualises education and career decisions as a socialised process. The socialised approach to education and career decision-making centres on socialised factors that determine education and career decisions (Hodkinson & Sparkes, 1997; Olsson & Martiny, 2018). The core assumption of the socialised perspectives is that socially constructed and prescribed conditions underpin education and career decision. Thus, as socialised individuals, individuals cannot autonomously make education and career decisions but mainly conform to prescribed social and cultural structures (Friedman-Sokuler & Justman, 2020). Thus, regardless of an individual’s biological and psychological innate abilities and tendencies, such as intellectual abilities, the individual will act and conform to these socialised frames concerning education and careers. Most of these social and cultural structures and systems include gender, race, ethnicity, socio-economic backgrounds and class (Hodkinson & Sparkes, 1997; Kerr & Kurpius, 2004; Olsson & Martiny, 2018; Raffo & Reeves, 2000). Theoretical perspectives such as gender schema theory, development intergroup theory, social cognitive theory, social role theory and gender incongruent role model and observational learning theory have been used to explore the socialised approach to education and career decisions (Agbley, 2015; Jones et al., 2018; Leaper, 2011; Mann et al., 2020; Olsson & Martiny, 2018).

One of the dominant areas in the literature concerns socialised education and career decisions based on gender. Research shows that individuals make education and career decisions that fit prescribed gender roles and gender schemas available to young people (Joyce & Farenga, 2000). Research suggests that gendered socialisation may considerably affect girls’ STEM education and occupational choices, even when intellectually gifted. Recent research shows that although talented girls are closing the gender gap in maths and science achievements, gifted girls are unlikely to choose STEM courses and careers (Butler, 2014; Kerr & Kurpius, 2004). For instance, a study followed 104 young women from their senior high school years into their mid-twenties. It confirmed their desire to conform to social roles of caring and nurturing, with the result that they value family-flexible jobs and prefer careers with minimal occupational time demands. Also, young women have lower intrinsic value for physical sciences, which can be rigid (Frome et al., 2007). Hence, most young women who prefer nurturing or caring roles are not encouraged to alter their career aspirations in favour of STEM. Another study found that gifted girls, especially those from
low-income backgrounds, encountered obstacles to reaching these career goals. There was little extra money for college tuition for girls who studied on the Talented At-Risk Girls: Encouragement and Training for Sophomores project (TARGETS), who were likely to drop out of school. There were also family-related obstacles, such as the need to earn money for the family and take care of younger family members; these limited young women’s ability to go away to school to pursue higher education (Kerr & Kurpius, 2004). Despite their psychological and biological predispositions and high STEM aspirations, these socially disabling conditions prevented gifted girls from studying STEM.

Another aspect of the literature on socialisation has extended the investigation from the socialised perspective to understand how socialisation and guidance can instrumentally counter the effect of deficit socialisation, which prescribes education and career choices for young people (Dockery et al., 2021). The majority of research has focused on the expansion of young people’s horizons and the challenging of stereotypes through exposing young people to role models, expanding social capital through career guidance and counselling services in school, and finally, providing employer engagement opportunities (Cheryan et al., 2011; Drury et al., 2011; Means et al., 2016; Olsson & Martiny, 2018; Rask & Bailey, 2002; van der Vleuten et al., 2016). For instance, Breda et al. (2020) studied 20,000 French high school students and 56 female scientists to determine whether a one-hour exposure to external female role models with science backgrounds would affect high school students’ STEM perceptions and STEM choices. Another study concerning STEM choice found that the intervention substantially affected girls’ STEM choices in Grade 12. The specific statistical change showed that the intervention increased the chance of girls choosing STEM courses at the undergraduate level by 28.9% (Breda et al., 2020).

Contrary to findings by Breda et al. (2020) and similar research, other studies suggest that role models do not significantly affect STEM choices among young women. For instance, a study examined the impact of a STEM career intervention to encourage girls to study STEM (Bamberger, 2014). The intervention involved 69 girls visiting female scientists as role models in a high-tech company. The primary findings from the analysis of the effect of the intervention on perceptions of scientists and engineers, the capability of dealing with STEM, and future career choices showed that young women value women scientists as intelligent and creative. Still, there was no significant change in the STEM career choices of young women. Bamberger (2014, p. 557) argued:

There is doubt concerning the perceived knowledge that role model interventions can encourage girls to pursue STEM careers. As a result of the
visits to the company, the research group girls were “frightened”: fewer students perceived a woman scientist or engineer positively; more students believed they could not deal with STEM, and fewer students chose a STEM major topic.

Olsson and Martiny (2018) used gender schema theory, arguing that individuals, especially children and young people, learn to connect men and women with specific attributes through observation in their homes, schools, and communities. They found similar inconsistencies in the existing literature research, including correlational and intervention research. The researchers argued that it is not clear if the presence of role models significantly affects the drive to choose STEM courses and careers. It was also unclear if counter-stereotypical role models lead children and young people to change. Although the socialised approach to explaining the education and career decisions among young people highlights relevant aspects of how social influence is subjective, it fails to account for how the emotional mediates the social. The literature was extensively dependent on the quantitative approach to research. Like the individualised conceptualisations, the socialised approach also provides a simplistic and mechanistic approach to decision-making. The socialised perspectives suggest that young people do not have the agency to think and mediate their life choices and must always conform to social orders that define and design education and career pathways.

2.4.3 A Triadic Approach to Education and Career Decision-Making

The literature has shown that individualised and socialised approaches to education and career decision-making are limited. What has become apparent is that the social (networks, socialisations) (Mann & Dawkins, 2014; Olsson & Martiny, 2018; Raffo & Reeves, 2000) and individual (biology, psychological) (Fouad, 1995; Rayner & Papakonstantinou, 2020; Santos et al., 2014) are interdependent. Therefore, some scholars have proposed a more complex, interrelated and pragmatic approach to education and career decision-making, arguing that the individual, social and policy elements determine education and career decisions (Hodkinson & Sparkes, 1997). The individual, social and policy factors are referred to here as a triad, with a combined power to influence how young people make their education and career decisions. Thus, the triad approach presents an agency and structure perspective to education and career decision-making while recognising that individuals can meditate, reflect, plan, and aspire towards specific fields of education and careers (Archer, 2014; Holland et al., 1998).
The existing literature concerning the triad approach is limited. Very few researchers have studied how individual characteristics such as interests, social factors such as family background, and education policies such as availability of counselling and guidance in school combine to influence learners' subject and career choices. Nevertheless, overarching theoretical perspectives such as the expectancy-value of achievement-related choice theory provide a complex and comprehensive approach to decision-making (Eccles, 2011a; Eccles et al., 1994). The model proposed and subsequently expanded by Wigfield and Eccles (2000) is discussed in the theoretical and conceptual framework session. It is further relevant to state that even though the model has been widely used to study the participation of young women in STEM, most research has examined the combined effect of the social and the individual with implicit or no account for policy effect. For example, Smyth and Hannan (2007) analysed the data of 4,000 students in 100 Irish secondary schools to investigate how school and student factors shape the take-up of biology, physics and chemistry in upper secondary schools. The study extended its enquiry to include intraindividual-level factors, both objective and subjective, such as attitude and class, school organisation and processes, and the school approach to science teaching within the school. Their findings showed that focusing on individual-level factors such as science attitudes is insufficient to explain STEM decision patterns. Instead, school-level factors such as guidance and counselling are necessary to improve young women’s participation in STEM. The study showed that it is relevant for young women to access sufficient information and guidance about science majors to ensure young women know the values associated with offering STEM majors.

2.5 Theoretical and Conceptual Perspectives

Substantially, the literature establishes that the underrepresentation of females in STEM education is not a matter of biology. Instead, the interactions between individual attributes, socio-cultural milieus and social actors significantly discourage capable females from choosing to pursue STEM-TVET programmes. However, studies investigating the underrepresentation of females in STEM education in the academic pathway, but not STEM in TVET pathways, are usually quantitative and focus on the Global North context. Accordingly, to contribute to existing literature, the current study aims to explore further the personal attributes and socio-cultural issues raised in the literature among young women pursuing STEM education in the TVET pathway at ISCED Level 3 in the Ghanaian context. The study proposes to explore further how young women decide to pursue STEM-TVET. As Wang et al. (2013) aptly argue, the underrepresentation of females in STEM is also a choice problem.
Furthermore, the current research proposes giving young women who study STEM-TVET at ISCED Level 3 a voice to narrate their experiences and aspirations related to pursuing STEM-TVET. Practically, the current research is an opportunity to bring a renewed perspective of optimism to the debate concerning the underrepresentation of females in STEM-TVET. Thus, instead of using a negative lens to investigate the barriers that prevent young women from pursuing STEM-TVET, the current research uses a positive lens to investigate the factors that encourage young women to pursue STEM-TVET. In doing so, the young women have the opportunity to talk about their lived experiences as students pursuing STEM-TVET. The knowledge gained from the narratives will bring about a dynamic perspective on explaining the underrepresentation of young women in STEM-TVET and will further reveal a potential mechanism that could bring change or improve the problem.

Moreover, to achieve the current research aims, it is crucial to investigate the diverse factors that intersect to encourage young women to pursue STEM-TVET. Regarding the proposition of comprehensively exploring a plethora of factors, a theoretical framework that can encapsulate an in-depth understanding of factors is necessary.

The current research seeks to make at least three original contributions to the existing body of knowledge. First, the proposed study is an opportunity to evaluate and validate the ideas and concepts presented by the selected theoretical framework. Most importantly, Eccles (2011b) noted that her experience as a scientist and science teacher in Ghana influenced her investigations of gender roles among non-western children and the subsequent development of the expectancy-value theory. Hence, it will be of value to evaluate how applicable the final assumptions of the expectancy-value theory are in the Ghanaian context. Secondly, the study employs interpretative phenomenological analysis (IPA) in education research (Noon, 2018). Therefore, another potential original contribution to knowledge would be to identify the potential strengths and weaknesses of addressing in educational research precisely the educational choices and lived experiences of females in STEM-TVET.

Likewise, it will be essential to assess the applicability of combining the expectancy-value theory, multiple attribute decision-making perspective and IPA as a qualitative methodology. Finally, the research can contribute to advancing the ongoing debates surrounding the STEM education paradox with findings from females’ participation in STEM programmes in TVET instead of the usual investigation of STEM along an academic pathway. The proposed research at this point will be the first to employ the expectancy-value theory of achievement-related choices and IPA to investigate the educational choices and lived experiences of young women pursuing STEM-TVET in Ghana. In conclusion, the
conduct and findings of the current research have the potential to advance understanding of the STEM education paradox.

2.5.1 Expectancy-Value of Achievement-Related Choice

Researchers have employed different theories to investigate the underrepresentation of females in STEM education. Examples are attribution theory (Atkinson, 1957); self-efficacy theory (Bandura, 2001); the sociological model of subject choice (Woods, 1976); the Breen-Goldthorpe model (Breen & Goldthorpe, 1997); and the integrated model of educational choice (Foskett et al., 2008). However, Eccles (1987) argues that these theories do not explicitly address the educational choices of females. Moreover, the theorists mentioned above propose objective quantities such as probabilities of success, incentives and rational choice while failing to consider students’ subjective appraisals of educational tasks in making educational choices (Rozensweig et al., 2019). Nonetheless, the expectancy-value theory of achievement-related choice addresses concerns related to females’ educational choices, especially in STEM (Eccles, 1987, 2007, 2011b; Wigfield & Eccles, 1994).

Eccles and her colleagues developed the expectancy-value theory of achievement-related choice based on two key concepts: expectations of success and subjective task values (Eccles, 1987). The concept of expectations of success is the subjective belief in one’s ability to succeed in a task. In contrast, the subjective task value refers to the anticipated fulfilment, importance and meaning attributed to a task (Eccles, 1987). Eccles (2011b, p. 511) explains that these two concepts have fundamental “psychological influences on educational and occupational choices and social roles and socialisation processes in multiple contexts.” The theory comprehensively and inclusively addresses why females make particular educational choices by considering a range of factors, including gender, identity, motivation, aspirations, and social and cultural beliefs and attitudes (Ball et al., 2017; Liben & Coyle, 2014; Wigfield et al., 2004). Most importantly, the theory allows females to evaluate and interpret the experiences, expectancies and values that influence their educational choices (Eccles, 1987, 2011a; Wigfield & Eccles, 1994). As Archer (2014, p. 5) states, “explaining what people do … involves references to agents’ subjective and reflexive formulation of personal projects in the light of their objective circumstances.”

Typically, research utilising the theory (Bøe et al., 2011; Masson et al., 2016; Matusovich et al., 2010; Wang & Degol, 2013) focuses on specific components, especially the subjective task value and expectations of success. Conversely, the current study proposes utilising all of the primary components of the expectancy-value model in Figure 2.3 while selecting the sub-elements. The selection of sub-elements depends on how the research can
qualitatively assess the elements and how relevant the elements are to the research goals and questions. For instance, under the component of stable child characteristics, gender is directly relevant to the current research regarding the ethnicity or aptitudes of young women or their siblings. Further, studies including Bøe et al. (2011), Eccles (2011a), Masson et al. (2016) and Wigfield & Cambria (2010) operationalise the sub-elements of the subjective task value as one of the components without explicit meanings. The original meanings and understandings of the expectancy-value theory of achievement-related choice concepts are relevant. However, the current research is cognisant that the narratives of the young women who are co-constructors of knowledge in this research may reveal different meanings, new components, and additional sub-elements of the model. As such, Bøe et al. (2011) and Wigfield & Cambria (2010) posit that there is a need for more in-depth qualitative research to expand the existing expectancy-value model by finding new components that are context-specific.

**Figure 2.3: Expectance-Value Theory of Achievement-Related Choice Model**

Source: Eccles (2011b, p. 512)

Like other research, the operationalisation of the four sub-elements of the subjective task value is of the essence in the current study. First, interest-enjoyment value refers to young women’s enjoyment gained from pursuing STEM-TVET. Wigfield and Cambria (2010) argue that while this element is similar to intrinsic motivation, it is the task that brings enjoyment. It will be necessary to encourage the participants to discuss how they enjoy
pursuing STEM-TVET and specific activities they enjoy assessing subject task value. Second, attainment value refers to the importance young women attribute to pursuing STEM-TVET. Attainment value incorporates identity. In order to assess it, it will be critical to ask young women how pursuing STEM-TVET is “central to their sense of self, or allow them to express or confirm important aspects of their developing self” (Wigfield & Cambria, 2010, p. 39).

In this research, identity is a process of identification that is “never achieved but must be continually done and redone” and is at the intersectionality of multiple social nexuses like gender and socio-economic status (Archer et al., 2015, p. 202). The third sub-element is utility value, which refers to pursuing STEM-TVET fits into young women’s valuable goals. In assessing utility value, it will be necessary to question young women about the usefulness, future relevance, and practicalities of pursuing STEM-TVET. Finally, the relative cost element in this study refers to what young women have to give up in pursuing STEM-TVET. Assessing relative cost will pertain to what young women have had to give up in the past or present and the anticipated efforts necessary to pursue STEM-TVET. While Masson et al. (2016) associated relative cost with negative cost, this study takes a neutral stance on cost (Wigfield & Cambria, 2010). Thus, young women in the study may not perceive cost negatively.

Another frequently operationalised component is affective reactions and memories. This study refers to young women’s positive and negative emotions and memories of pursuing STEM-TVET. Like Masson et al.’s (2016) assessment of affective reactions and memories, it will be critical to question young women about activities concerning subject domains and to reflect on their successes and failures. Affective reactions and memories can reflect women’s interpretations of previous and present achievement outcomes (Wigfield & Cambria, 2010). Another usually operationalised component is self-schemata. This study refers to the cognitive representations of young women from past experiences to interpret STEM-TVET experiences, which can manifest in goals and identities. Thus, young women’s self-schemata can reflect their actual or ideal self, associated with identity competencies in STEM-TVET skills, abilities and goals (Eccles, 2009). In assessing this component, it will be critical to question young women about their short-term and long-term goals and how these relate to past experiences and identities.

Although the expectancy theory of achievement-related choice provides a comprehensive and inclusive framework for assessing multiple reasons for educational choices, it fails to explore how students evaluate different factors and alternatives when making educational choices.
Therefore, based on examining and describing how young women decide to pursue STEM-TVET education, the current study proposes drawing on the perspective of multi-attribute decision-making (MADM) (Yoon & Hwang, 1995). Scrutiny of other decision-making theories, including rational choice theory, the theory of risk aversion and the adaptive decision-making model, reveals that the theories are primarily normative and prescriptive and fail to describe decision-making processes beyond individualist and minimalist factors. For instance, rational choice theorists argue that decision-makers will make choices that will mainly increase economic gains.

However, critics of the rational choice theory argue that the theory fails to explain decision-making that can happen beyond self-interest (Boudon, 2003). It fails to explain inconsistencies in decision-making. Hence, rational choice theory cannot adequately explore decision-making in an educational context, where choices depend on factors beyond self-interest and deviations from rational choice are evident. For example, Aryeetey et al. (2013) combined rational choice theory and the integrative educational choice model to study apprenticeship preferences among Ghanaian youth. However, they failed to analyse the decision-making process because of the inadequacies of the theory and model underpinning the study. MADM suits the aims of this research in terms of analysing and describing the decision-making processes of young women pursuing STEM-TVET education.

Complementary to the expectancy-value theory of achievement-based theory, MADM can facilitate a description of how young women evaluate attributes that influence their decision to pursue STEM-TVET education. MADM assumes that decision-makers evaluate and analyse multiple attributes of two or more alternatives in the decision-making process to select the most desirable alternative based on subjective value to the individual (Ding et al., 2016). Harte and Koele (2001) argue that applying the MADM depends on the assumption that decision-makers have all the relevant information about alternatives from the presentation of the choice problem to the final decision. In this case, the assumption is that young women have relevant information about all programmes at ISCED Level 3 in Ghana. It makes it possible to explore how young women subjectively evaluate the attributes of different alternatives in choosing to study STEM-TVET instead of non-STEM-TVET programmes. Although MADM is well-known in quantitative fields like economics, studies like Guilherme and Lobo Pimentel (2011) and Harte and Koele (1995) show that studying individuals’ decision-making processes qualitatively with MADM is efficient, realistic and transparent.
2.6 Summary

The current chapter has explored the under-participation of young women in STEM-related TVET courses in the context of TVET for development. This has been explicated in four themes presented in this chapter. First, TVET for development in Africa has been theorised in terms of the perceived purposes of VET with an ecological frame – human capital is for macro-level benefits and purposes, such as economic development and growth. Human rights and sustainable development are forms of meso-level development, such as community and social development, whiles human development and capabilities are to the micro-level, particularly the relevance of TVET to the learner. The learners become sustainable producers and productive citizens of countries for economic development.

Moreover, the functions of VET appear to fit different purposes and attract different actors and stakeholders. What is evident is that the purpose and function of TVET are not isolated from other social, economic, and political contexts. Further, suppose TVET is to maintain its purpose despite all the challenges it faces, such as poor social perception and unattractiveness, challenges with employer engagement in training, the gender paradox and limited research. In that case, it has to navigate these sectors in a systematic approach. What is missing in the STEM and TVET literature is an understanding and explanation of why these young women choose to study STEM-related TVET courses and how the strategies used by these young women can improve their participation of young women in STEM-related TVET courses. Another limitation of the literature so far is the absence of discussion of the processes young women use to choose STEM education and careers in TVET. Thus, there is a gap in understanding the education and career decision-making process adopted by young people, especially those from disadvantaged backgrounds, who cannot access education, career guidance, and counselling.

The second theme demonstrates how the existing literature theorises the under-participation of young women in STEM. The existing literature has conceptualised the under-participation in STEM in general without extensive focus on the conceptualisation of the under-participation of young women in STEM-related TVET fields. The existing research generalises STEM; however, it is apparent that the conditions of studying STEM-related TVET courses differ from those of studying STEM in the general academic stream. It follows that it is problematic for research to focus only on STEM in the general academic stream and to make generalised assumptions. The existing literature proposes that political barriers such as inadequate inclusive policies in STEM, cultural practices such as family responsibilities for females and social barriers such as gendered work socialisations restrict young women
from participating in STEM-related TVET courses. These conceptualisations are relevant in interpreting how research has helped understand the problem and the approaches recommended to solve it. However, there is a gap at this point in the literature. Using these barriers to conceptualise the problem limits the scope of understanding. In recent global and country-based test evaluations in science and maths, elements such as biological differences are subjective. Other scholars have used these barriers to develop problematic notions, such as the *leaky pipeline* of STEM, which does not do justice to the substantial issue of how to improve the participation and representation of young women in STEM across different spectrums of education and careers.

The third theme explores STEM identities among young women. This theme posits that young women have an idealised identity that essentially does not fit the identity of STEM; this is explained in the literature as self-conceptualisation and focuses on young women’s suitability for STEM education and careers. This idealised self-conceptualisation serves as a conforming social role for most young women. Young women conform to social identities to help protect themselves from stereotypes. Their fear of not being good enough intellectually and physically is related to their reluctance to pursue STEM. There is also an issue of young women being feminine to enter STEM, an area traditionally defined as a masculine field. There is a more significant discrepancy between young women’s prescribed selves as being feminine according to society and their idealised selves of choosing a STEM education and career. However, when young women perceive themselves according to their STEM capability and competencies rather than in light of socially prescribed selves, they choose STEM education and career without significant social threat or STEM-identity discrepancy. However, the literature fails to explore young women’s identities who study STEM-related TVET courses in upper secondary schools and how their STEM identities develop over time.

The final theme emphasises that STEM education and career choice are complex, influenced by multiple individuals and social and policy factors. Despite the long-standing effort to improve diversity in STEM, from medical sciences and biology, most STEM fields have very few girls and women participating; this is particularly true of technical fields, such as engineering. Although individual and social factors dominate the explanations of why young women may choose STEM education and career, this literature review has shown that most researchers fail to provide a complete picture of this complex process. The assumption is that young women do not decide to choose STEM education and careers in a vacuum; social forces impinge on their abilities, biological predispositions, and psychological traits.
Further, social factors do not work in isolation; policies and structures impinge on social factors to structure the outcomes of young women’s STEM education and career decisions.

In conclusion, this chapter has reviewed the existing literature to identify how the existing literature debates and conceptualises the underrepresentation of females in STEM education and the theoretical frameworks that have guided the field. From an extensive consideration of theories used in studies in this research tradition, the expectancy-value theory of achievement-related choices emerges as the most prominent and inclusive theory that can encapsulate multifaceted reasons in different contexts. Further, the research proposes drawing on the multiple attribute decision-making approach to complement the leading theory. A triadic approach is proposed, where the individual, social and structural approaches are researched in a much broader context. This approach invites researchers to consider an agency and structure perspective on STEM education and career decision-making processes. The agency and structure perspective enables the investigation into how the individual navigates personal projects, in this case, STEM education and career aspirations. It provides evidence that STEM aspirations and decisions exist not in a vacuum but in environments where social and policy structures are both enablers and constraints. Decision-makers must navigate these enablers and constraints to release their STEM decisions and aspirations.
Chapter 3. Ghana’s Upper Secondary TVET Context

The current chapter explores how Ghana’s upper secondary TVET system and how the under-participation of young women in STEM-TVET in technical institutes has been shaped by education policies. In this thesis, understanding Ghana’s TVET provision and policy context led to the study of how written TVET policy discourses influenced practices that concerned young women’s participation in STEM-related TVET courses in Ghana’s Technical Institutes. First, the chapter provides a contextual overview of the provision of TVET in Ghana with an emphasis on the provision TVET at the upper secondary level. The chapter then discusses the findings of a Critical Discourse Analysis (CDA) of relevant TVET policy document in the last decade. The discussions highlight TVET policy discourses in five major policy documents and the findings are presented thematically according to the practical argumentation perspective proposed by Fairclough (2013). The processes of conducting a CDA for the thesis and why it was the appropriate method to analyse Ghana TVET policies are discussed in the methodology chapter.

3.1 The Vocationalisation of Secondary Education in Ghana

Historically, TVET has been poorly perceived and relegated to the background as a second chance or second-tier preference compared to grammar school education pathways in Ghana (Darvas & Palmer, 2014). The poor and those perceived as academically limited are those pushed into TVET. For instance, the historic unattractiveness of TVET is captured by Foster in his seminal paper ‘The Vocational School Fallacy in Development Planning:

The paradox in Ghanaian education has been the emphasis placed on vocational and agricultural training in all documentary sources and the relative absence of it within the existing system of education. (Foster, 1966, p. 144)

Foster’s analysis revealed that, in practice, the preference for western education was primarily tailored towards the increasing provision of more academic schools and the taste for white occupational opportunities generated within the exchange and service sector of the economy. It was rational for graduates from these academic schools to gravitate from subsistence activities to occupations within the formal sector (Foster, 1966).

As Ghana evolved through its independence, a clear agenda emerged for the vocationalisation of secondary education through the 1987 Education Reforms (Akyeampong, 2002). A UNESCO analysis of TVET in Africa around that period showed Ghana’s broad technical and vocational education objective. The goals were as follows:
1. To expose pupils at the Basic Education level to a range of practical activities in the vocational field to make them familiar with and stimulate their interest in vocational subjects and give them equal opportunity to choose their future careers in either the technical or general area.

2. To equip students who have completed Basic Education with those occupational skills that will enable them to enter gainful employment in industry and commerce.

3. To equip students with the relevant productive and entrepreneurial skills to prepare them for self-employment.

4. To provide trained human resources in science, technology, and commerce, matching the supply of skilled labour with demand.

5. To provide personnel with the technical knowledge and vocational skills necessary for agricultural, industrial, commercial, and economic development while at the same time paying attention to environmental issues.

6. To give training and impart the necessary knowledge and skills to the workforce, providing operatives, artisans, artisans, technicians, and other middle-level technical personnel.

7. To enable the youth to understand the increasing complexity of science and technology through systematic exposure to modern technology.

8. To encourage the increased participation of women in education, training, and employment in the technical field.

9. To provide a sound foundation for further education for those students who may wish to continue their education later in lifelong education. (UNESCO, 1996, p. 93)

Over the years, Ghana has seen several TVET reforms and programmes. Most of the forms of educational reforms and policies are initiated by the Ministry of Education usually in consultation with major stakeholders. The TVET system has recently had some major reforms and initiatives. These include TVET for Disabled, Ghana Skills and Technology Development Project, The National Apprenticeship Program, Ghana Skills, and Technology Development Project; Ghana Skills Development Initiative (a GIZ Consultants’ – COTVET cooperation), Technical and Vocational Education Voucher Program, Competency Based Training, Support to Private Sector Development; Development of Skills and Industry Project; and
Workplace Experience Learning Policy. Also, the training of 200 TVET teacher at different higher qualification levels for the development.

3.1.1 Ghana’s TVET System

Ghana’s Technical and Vocational Education Training (TVET) system is made up of the formal and informal systems. The formal school-based TVET system is provided at the Secondary and Tertiary levels of the mainstream education system in Ghana, whiles the informal system is usually available through a master craftsman apprenticeship scheme. The duration of the formal TVET structure is 3 years and TVET teachers have training at teacher training colleges and the University of Cape Coast. The time frames for informal programs are usually designed based on the number of years allocated by the master craftsman. Ghana’s TVET system comprises three primary sectors coordinated by the Council for Technical Vocational Education and Training (COTVET).

3.1.2 Governance

The entire education system in Ghana is overseen by the Ministry of Education and the Ghana Education Services. Nonetheless, The Council of Technical and Vocational Education Training (COTVET) is a special secretariat convened by the ACT (718), as the major directorate that implements policies, monitors, governs and evaluates the entire TVET system in Ghana. The council was inaugurated on 14th April 2010, with four standing committees perform specific functions of COTVET. They are the National TVET Qualifications Committee (NTVETQC); which regulates the national TVET qualification framework, The Industrial Training Advisory Committee (ITAC); ensures quality workplace training and occupational standards of trade unions and industries, The Training Qualify Assurance Committee (TQAC); ensures institutions and awarding bodies deliver satisfactory standards and finally the National Apprenticeship Training Committee (NATPC); ensures the delivery of quality informal apprenticeship schemes.

3.1.3 Funding

The Government of Ghana is the main financier of formal TVET schools at different educational levels. Some religious institutions and NGOs support the government in providing funds for their established schools which formal part of the formal and informal sectors. International Organizations like the UNESCO-UNEVOC, German Development Cooperation, The Korea Development Cooperation, the World Bank, and the African Development Bank are key international organizations that provide resources for the TVET system in Ghana. The
Skills Development Fund is currently the most comprehensive funding source of TVET in Ghana now.

3.1.4 Providers

The informal TVET system is largely provided by young entrepreneurs and master craftsmen who have the capacity and resources to train others. This pathway is perceived to be patronised by school dropouts and people who are unable to access higher education. Other providers are NGOs, religious organisations and international organisations through initiative programs. The government also the largest provider of formal TVET through secondary technical schools, polytechnics, and universities. According to the TVET structure, provided certify learners’ proficiencies according to the National Qualification Framework as shown in Figure 3.1.

Figure 3.1: Ghana's National Qualification Framework

Source: (COTVET, 2019)

3.1.5 Upper Secondary TVET

Primarily, prevocational training takes place at the basic education level in the junior high schools before upper secondary TVET provision, and the aim is to stimulate learners’ interests in TVET programmes and to equip them with foundational skills in TVET (Dadzie, Fumey, and Namara 2020). As of the 2017/2018 academic year, there were forty-seven Ghana
Education Service (GES) upper secondary TVET institutes, with a student population of about 54,186 (Ministry of Education 2018). At the end of the compulsory basic education system in Ghana, pupils have the option to access upper secondary education. Pupils who choose upper secondary TVET have two pathways: the Senior High Technical Schools and Technical Institutes. While, Senior High Technical Schools, offer a combination of science courses such as chemistry and biology with TVET courses such as electrical engineering, Technical Institutes on the one hand offer pure TVET courses such as without any science courses. It is important to note that both pathways are for 3 years. The qualification to access any of the two options is the West African Basic Certificate Examination taken at the junior high level. The thesis centered on Technical Institutes as these schools in the Ghanaian contest are considered as the pure STEM pathways in Ghana’s TVET system.

As of the 2017/2018 academic year, there were 47 Ghana Education Service (GES) upper secondary technical institutes, with a projected increase in student enrolment to 741,159 by the 2020/2021 academic year (Ministry of Education 2017). Technical institutes are all public pure TVET schools that the Ghana Education Service manages. Technical institutes offer specialised TVET programmes such as mechanical engineering, electrical engineering and automation, catering and hospitality, business, printing, computer hardware technology, and fashion design, in addition to general academic courses: mathematics, social studies, general science, and English language (Arthur-Mensah and Alagaraja 2013). Technical institute learners after successful examinations in theory and practice, they receive certifications recognised by higher education institutions and employers.

In many cases, STEM provision in Technical Institutes centered on the application of science through technology and engineering-focused programmes. Currently, Technical Institutes across Ghana offer about 22 STEM programmes. Some of these STEM programmes include autobody works, motor vehicle engineering, welding, and fabrication technology, diesel-mechanical/heavy engine, heavy-duty auto-mobile, industrial mechanics mechanical, engineering technology, minor engine repair, electrical engineering technology, and electrical machine/motor rewinding. Others are agricultural mechanisation technology, refrigeration & air-conditioning technology, electronics engineering, computer hardware technology, information technology, computer networking, software development, database management, digital designing technology, plumbing and gas fitting technology, building construction technology, and architectural drafting. It is important to note that the norm is for each technical institute to offer at least four STEM-related courses but not all.
Generally, the TVET system expectation is for technical institutes to have workshops for STEM practical lessons. Evidence shows that most schools have STEM workshops. However, over 50% of these school-based STEM workshops lack the necessary modern technological tools, materials, and machinery for practical lessons (Darvas and Palmer 2014; Wojcichowsky 2016; Amegah 2021). In a recent study, Amegah (2021) investigated employer engagement in technical institutes in Ghana and reported that all headteachers interviewed complained about inadequate machinery, tools, and materials deemed necessary for students to engage with employers and international development agencies. Over 90% of technical institutes, nonetheless, had developed institutional strategies to complement practical-based learning in technical institutes. For instance, all the three technical schools studied had developed different strategies for practical-based learning. One of the schools had accepted to pilot the German dual system with local community-based industries for learners to assess industries with tools, machines, and materials (Amegah 2021).

After the required theoretical and practical skills are acquired, learners are awarded the case the technical institutes, they receive certification 1 and 2, thus students can receive two certifications. The first is the Technical Examination Unit Certificate II, and the second is the National Board for Professional and Technician Examination Certificate (NABPTEC), which some employers recognise for employment and technical universities or some general universities admissions. (UNESCO-UNEVOC 2016). The strength of dual certification in TVET is what Winch (2013) articulates as ‘TVET training and qualifications have dual value; as passports through education and as accreditation in the labour market’.

Moreso, to increase and widen access to TVET opportunities for Ghanaian youth especially school-dropouts, young women and persons with disabilities, the Government of Ghana with the support of multilateral agencies like the World Bank and African Development Bank and other development agencies including Japan International Cooperation Agency (JICA) and the German Development Agency (GIZ) continue to implement short-term and long-term TVET projects such as the ‘Youth Inclusive Entrepreneurial Development Initiative for Employment (YIEDIE), the Ghana TVET Voucher Project, and the Apprenticeship to Entrepreneurship Project implemented by the National Board for Small Scale Industries (NBSSI)’ (Dadzie, Fumey, and Namara 2020, 28).

To better understand the provision of TVET in upper secondary TVET schools and how labour market expectations are relevant to this provision. One of the most important aspects of
the labour market expectation is how employers engage in upper secondary TVET provision. Generally, the expectation of employer’s engagement in upper secondary TVET provision is for students to access industries to gain additional technical skills and competencies that industries demand (Darvas and Palmer 2014). Meanwhile, over the decades, it has become a concern that upper secondary TVET learners could not meet labour market skills demand and the primary problem is that many employers do not engage with upper secondary TVET institutes (Darvas and Palmer 2014). Recent efforts to mitigate the under engagement of employers with upper secondary TVET institutes have included the introduction of the competency-based training (CBT) curriculum at the upper secondary TVET level (Arthur-Mensah and Alagaraja 2013). COTVET believes that the CBT curriculum will improve practical learning by ensuring the proper placement of students in industries, the provision of work orientations, and the assessment of skills proficiency according to industry standards (Arthur-Mensah and Alagaraja 2013). Ansah (2012) further asserts that CBT is fundamental to matching learners’ skills and competencies to current labour market standards. One major drawback of CBT from an employer engagement perspective is that it can limit learners from acquiring general disciplinary knowledge needed beyond their immediate occupational fields (Wheelahan 2009).

The low employer engagement in TVET is a historical concern for Ghana’s TVET system and it has sabotaged the direct engagement of upper secondary TVET learners in labour market after training. For instance, Darvas and Palmer (2014) found that one of the reasons for low employer engagement in TVET in Ghana is that ‘there is often an information imbalance about the benefits of, and returns to, learning and training, which can result in under-investment in skills development by employers’ (p.23). Also, negative perceptions about TVET, unattractive incentives for employer engagement in TVET and perceived sub-standard training in TVET institutions continue to exacerbate the weak links between employers and TVET institutions in Ghana (Okae-Adjei 2017; Wojcichowsky 2016; Webster and Sausner 2017). Therefore, though the general expectation is for upper secondary TVET to have the option to join the labour market, that expectation is hardly achieved.

3.1.5 Post-secondary TVET
This is a higher level TVET provided at universities and polytechnics which is conventionally accessed by students who have a secondary training in VET at any technical or secondary technical institutions across the nation. Usually, a pre-technical course qualification certificate from National Board for Professional and Technical Examinations (NABPTEX) or the West
African Examination Council for secondary technical schools is needed to enter a polytechnic whereas a Higher National Diploma is the qualification to continue for a degree. At the post-secondary level, the polytechnics offer tertiary Programme for 3 years which leads to a Higher National Diploma, and a Bachelor of Technology certificate for a 4-year program at a university. Craft Certificate for Advanced Technician and Crafts are awarded for 2-3 years program in Advanced Technician courses. The NTVETQF provides accumulating eight levelled qualifications which are: Doctor of Technology, Master of Technology, Bachelor of Technology, Higher National Diploma, National Certificate II, National Certificate I, National Proficiency II and National Proficiency I.

3.1.6 In Formal and Non-Formal

The in formal TVET is commonly provided by civic organizations, Non-Governmental Organizations (NGOs) and individuals. It comprises short programs, apprenticeships and sessions that led to a certificate for informal skilled work or self-employment. Further, the informal TVET is accessible through an apprenticeship arrangement under master craftsmen. This option will last for three to four years or further depending on how students acquire the set skills within the given time frame. These programs can provide a student with a national apprenticeship certificate; if the institution is accredited and the student writes the National qualification exams provide at the National Vocational Training Institute (NVTI). The non-formal sector is an enterprise-based system with on-the-job-training delivered by community-based vocational training centres, not-for-profit organisations and other private TVET providers (COTVET 2016). For instance, graduates from the non-formal TVET sector have two options for obtaining a certification from an informal sector trade association. Then a second option of taking and passing a nonwritten, competency-based skill test proficiency exams to receive a proficiency certificate issued by the National Vocational Training Institute (Dadzie, Fumey, and Namara 2020). It is clear that there are a variety of TVET sectors and providers in Ghana; however, one major drawback with such a system is inadequate coordination (Darvas and Palmer 2014).
3.2 Ghana’s TVET Policy Context

Like most low-income countries in Africa, what became paramount in Ghana’s development policy was the need to improve the quality of human resources, which was vital to the country’s economic, social, and political development. The general assumption, reflected by the education policies reviewed for this study, was that for Ghana to build quality human resources and influence socio-economic development, the labour force needed to become more productive through increased knowledge and skills. Similar policy trends for human resource development are noticeable in the recent ESPs and education policy reports. For instance, the ESP 2010–2020 showed that Ghana’s TVET agenda was to integrate the diverse types of formal and non-formal TVET sectors into a specific comprehensive demand-driven system. For these policymakers, a demand-driven TVET system (that focuses on the skills industries demand from workers) was the critical strategic goal to build human resource capital to increase manufacturing and industrialisation (Ministry of Education, 2012). These policy discourses fail to emphasise that apart from education and training, there are other relevant approaches, such as the investment in modern technologies that can make Ghana’s labour force more productive.
However, a review of Ghana’s TVET agenda since independence showed that Ghana was not achieving the economic agenda prescribed for TVET. It has been identified that the “over-ambitious nature of policy goals, poor conceptualisation, lack of effective planning and implementation, inadequate funding have all contributed to undermining any potential benefits that reformers might have intended” (Akyeampong, 2002, p.viii). Other recent policy documents contextualise similar challenges despite the efforts to improve TVET in Ghana. One problem captured in recent education policy documents is gender disparities in TVET, specifically STEM-related TVET. The acknowledgement of gender disparity in education and training comes from the United Nations’ Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs). What was missing from TVET policy strategies in the early 2010s was the policy agenda that targeted young women's participation in STEM-related TVET courses. Most of the gender, inclusion and parity discourse focused on equality in primary education and bridging the gender gap in access to education (Ministry of Education, 2012).

While setting the participation of young women in STEM-related TVET courses as an agenda has been gradual, it has gained significant momentum as the global call for diversity in skills development and STEM grows. Most of these policy documents from 2013, especially the education reports on TVET, discuss the under-participation of young women in STEM-related TVET courses as a central TVET policy concern. For instance, the National TVET policy plan did consider other forms of inequality, such as the status of students with disabilities in TVET, inequalities in resource distribution, and gender inequality in rural areas. However, the analysis below will show that it failed to highlight the extent of the under-participation of young women in STEM-related TVET programmes (COTVET, 2016). So, despite a general gender parity agenda in most education and training policies, these gender parity goals failed to recognise the under-participation of young women in TVET as a policy issue until recent times. The analysis of selected policy documents expands on this argument and further shows how the discourse concerning the under-participation of young women in STEM-related TVET courses has evolved as an education policy target. Table 3.1 provides a list of education policy documents analysed for this discussion.

<table>
<thead>
<tr>
<th>Table 3.1: List of Education Policy Documents</th>
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<tbody>
<tr>
<td><strong>Title</strong></td>
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<table>
<thead>
<tr>
<th>No.</th>
<th>Title</th>
<th>Year</th>
<th>Author/Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Education Strategic Plan 2010–2020</td>
<td>2012</td>
<td>Ministry of Education</td>
</tr>
<tr>
<td>3.</td>
<td>Education Strategic Plan 2018–2030</td>
<td>2018</td>
<td>Ministry of Education</td>
</tr>
</tbody>
</table>

Source: Author

The primary focus CDA of the education policy documents was to identify and understand the implicit and explicit discourse about the trajectory of TVET policy in Ghana and how that has defined the participation of young women in STEM-TVET over the last decade as a policy target. I further narrowed the focus of this CDA to identify sub-sections of the policy documents focused on TVET policies that discussed young women’s participation in STEM-related TVET programmes. The first reason for identifying sub-sections that specifically discussed young women’s involvement in STEM-related TVET courses as policy targets were to unpack the level of attention given to the under-participation of young women in STEM-related TVET courses as a problem. The second reason was to identify and evaluate the strategies designed to solve Ghana’s problem for the last decades. Additionally, overviews of these documents provide a contextual understanding and historical trajectory of the discourse of TVET and young women’s participation in STEM-related TVET courses as a policy target.
The discussions begin with an overview of Education Strategy Plans from 2010–2030. The background of the ESPs provides an understanding of the fundamental agenda of education policies. These backgrounds helped to contextualise the relevance of the ESPs for the current research. These background summaries provided a broader sense of how each policy document’s discourse evolved and the political economy of the period when these policy documents were designed. It also aids the understanding of how these policy discourses could contribute to the participation or under-participation of young women in STEM-related TVET programmes.

More so, the section discusses the four selected TVET policy reports that were relevant to the research question. The four documents are: From Prejudice to Prestige: Vocational Education and Training in Ghana, Women in TVET: Input into Ghana’s COTVET Gender Strategy Dialogue for the Global Learning Centres, Demand and Supply of Skills in Ghana: How Can Training Programs Improve Employment and Productivity? and MyTVET Campaign Report. The analysis of these four TVET policy reports provides a general understanding of how other policy actors, such as development organisations and TVET agencies, discussed the under-participation of young women in STEM-related TVET courses and the solutions provided to address the problem.
<table>
<thead>
<tr>
<th>Practical Argument</th>
<th>Extract</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Circumstantial premise</strong></td>
<td>No direct circumstantial premise about the problem. The problem discourse was more about the misalignment between TVET demand and supply.</td>
</tr>
<tr>
<td><strong>Goals premise</strong></td>
<td>“The thrust of the TVET policy is to integrate the various types of formal and non-formal TVET, from the elementary to the tertiary levels, into a single comprehensive demand-driven system, under a single umbrella management Council for TVET COTVET” (p. 16)</td>
</tr>
<tr>
<td></td>
<td>“Significant expansion of Second Cycle Education, especially TVET meeting the 75% GER target by 2015 adds more than 1,600 m to Second Cycle costs over the plan period” (p. 41).</td>
</tr>
<tr>
<td><strong>Value premise</strong></td>
<td>“Provide Technical and Vocational Education and Training (TVET) to enhance middle-level management and TVET delivery at all levels. Introduce science and TVET innovations within the system” (p. 15).</td>
</tr>
<tr>
<td><strong>Means-goal premise</strong></td>
<td>“Improve efficiency and management of the system”</td>
</tr>
<tr>
<td></td>
<td>Improve the trainability of the workforce</td>
</tr>
<tr>
<td></td>
<td>Improve training quality and relevance</td>
</tr>
<tr>
<td></td>
<td>Promote productivity in agriculture through TVET</td>
</tr>
<tr>
<td></td>
<td>Build a human resource base for increased manufacturing and industrialisation</td>
</tr>
<tr>
<td></td>
<td>Develop a world-class workforce</td>
</tr>
<tr>
<td></td>
<td>Promote productivity in the informal sector through TVET</td>
</tr>
<tr>
<td></td>
<td>Build capacity for ICT for global competitiveness</td>
</tr>
<tr>
<td></td>
<td>Develop and implement a National TVET Qualifications Framework” (p. 16).</td>
</tr>
</tbody>
</table>

Source: Author
3.2.1 Education Strategic Plan 2010–2020 (2012)

The Education Strategic Plan (ESP) 2010–2020 was the first education policy document published during the period under review. The ESP 2010–2020, commissioned by the Minister of Education at the time, Hon. Betty Mould-Iddrisu was published ten years after the establishment of the MDGs. It was one of the strategic plans to drive Ghana’s education for a decade. Hon. Betty Mould-Iddrisu was the only female Minister of Education appointed between 2000 and 2012, and she held the position from 2011 to 2012. The other female education Minister of Education after her, who continued to implement the agenda of the ESP 2010–2020, was Hon. Naana Jane Opoku Agyeman, who was in office from 2013 to 2017. The agenda of the ESP 2010–2020 drew on five broad strategies: expanding universal primary education, poverty reduction, national development, the 2007 Education Reform, and the 2008 Education Act. The first agenda for the plan was to expand access to education and achieve the Education for All goals. It is, therefore, not surprising that the general approach of the document was to increase overall access to education but did not target specific access issues such as the under-participation of young women in STEM-related TVET courses. For instance, Table 3.2 shows the ESP 2010–2020 goal of expanding TVET without a specific goal for the direct expansion of female participation in STEM-related TVET courses.

Moreover, the position of the document to expand access was not surprising because that was the global campaign of the time, especially with a global drive to increase gender parity and universal access to education before the end of the MDG period. As both Ministers of Education were female, it was not surprising to further notice that the document presented a clear interest in increasing women and girls’ access to education, especially those with disabilities and those from rural areas. Therefore, a general assessment of the education sector’s performance showed that by 2011 the primary school net enrolment rate was around 84%, which according to UNICEF, was ahead of most sub-Saharan countries. By 2015, 90% of children in Ghana were enrolled in school, with the literacy rate for males and females aged 15–24 at 82% and 80%, respectively (Ministry of Education, 2013; The World Bank, 2011). At this stage, the focus of the policy agenda was increasing overall access to education. Although the sub-sector policy on TVET in the ESP 2010–2020 aimed to incorporate the distinct types of formal, informal, and non-formal TVET provisions for system change and access expansion. The goals were very human capital-oriented, emphasising workforce development. The general plan of the policy was to revitalise Ghana’s TVET system to make it more responsive to the economy’s present and future skills
needs. However, little was paid to making all forms of TVET, such as STEM-related TVET, inclusive of minority groups such as girls and women.

Thus, the main focus of the ESP 2010 was on expanding TVET and creating a system of change that made TVET demand-focused by providing needed skills to drive productivity for industrial development. Although a critical agenda at the time, it limited the focus of the TVET sector to employers’ demands and the development of a public-private partnership (PPP) to cut the cost of TVET provision and expand the provision of TVET in Ghana. For instance, making TVET demand-driven was an independent strategy to have “two-way support for PPPs in return for private support to TVET; the government will provide tax holidays and tax exemptions on imported equipment” (Ministry of Education, 2012, p. 31).

The discussion thus far has shown how the ESP 2010–2020 failed to target the under-participation of young women in STEM-related TVET courses as a policy concern. The participation of young women in STEM-TVET did not receive any attention. Therefore, the practical argumentation analysis in Table 3.2 revealed ten means-goals of the ESP 2010–2020 to make TVET demand-driven and expand TVET to meet the labour force and productivity. However, the ESP 2010–2020 failed to focus on the under-participation of young women in STEM-related TVET courses as a circumstantial premise; therefore, there was no single means-goal to address the problem.

### 3.2.2 National TVET Strategic Plan 2015–2025 (2015)

Five years after the ESP 2010–2020, under the directive of a new female Minister of Education, Jane Naana Opoku Agyemang, the launch of the National TVET Strategic Plan 2012–2025 coincided with the development and global transition from the UN’s MDGs to the SDGs. MDG 2 focused on the broad educational goal to achieve universal primary education, while SDG 4 expanded this to ‘ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. SDG 4 provided more nuanced educational and gender equality targets that emphasised girls’ and women’s access to and participation in educational fields traditionally reserved for boys and men. For instance, SDG 4 Target 3 stated that by 2030, equal access should be ensured for all women and men to attend affordable, quality technical, vocational, and tertiary education, including university. Also, Target 5 emphasises the elimination of gender disparities in education and points to the need to ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, Indigenous peoples, and children in vulnerable situations, such as refugees and displaced children. These targets provided a specific focus that was lacking in MDG 2.
The National TVET Strategic Plan was intended to be a long-term renewal approach for Ghana’s TVET system, intending to make the TVET sector responsive to the future skills needs of Ghana’s economy (COTVET, 2016). The values premise stated in Table 3.3 reveals this agenda. Thus, the overall objective of Ghana’s TVET policy was to create a workforce that could transfer accrued and needed technical knowledge and skills into economic use, thereby reducing poverty and social and economic exclusion. Table 3.3 shows that beyond this, the practical argumentation analysis of the National TVET Strategic Plan 2012–2025 revealed a circumstantial premise of the under-participation of young women in the STEM-related TVET sector. Therefore, unlike the ESP 2010–2020, this National TVET Strategic Plan provides a means-goal premise that tries to address the under-participation of young women in STEM-related TVET courses. For example, it proposes the need to “ensure gender mainstreaming of all new competency-based training (CBT) materials and all new CBT material assessed as gender-sensitive” (COTVET, 2016, p. 51).
**Table 3.3**: Practical Argumentation of the National TVET Strategic Plan

<table>
<thead>
<tr>
<th>Practical Argument</th>
<th>Extract</th>
</tr>
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<tbody>
<tr>
<td>Circumstantial premise</td>
<td>“Several reviews of TVET in Ghana have pointed out gender equity issues. Most young people enrolled in public TVET are male, except in Community Development and Social Welfare VTIs. Many public training facilities, especially traditional male occupations, lack changing rooms and toilets for female learners. Women tend to gravitate towards training in traditionally female occupations, where women’s facilities are provided” (p. 21).</td>
</tr>
<tr>
<td>Goals premise</td>
<td>“Increased enrolment of females in traditionally male areas” (p. 35).</td>
</tr>
<tr>
<td>Value premise</td>
<td>“A world-class industry-led TVET system which prepares a globally competitive workforce for the social and economic transformation of Ghana” (p. iii). “Deliver high-quality skills development programmes and TVET qualifications recognised by local and international labour markets” (p. iii).</td>
</tr>
<tr>
<td>Means-goal premise</td>
<td>“Increase access and participation by sensitising pupils and parents to career opportunities in TVET (p. v). Gender mainstreamed into new competency-based training materials (p. 51). All new CBT material assessed as gender-sensitive” (p. 51).</td>
</tr>
</tbody>
</table>

Source: Author
Further, the goal premise of the National TVET Strategic Plan in Table 3.3 assumes that TVET must primarily respond to all learners’ competence needs, including those of young women. The goal premise aimed to increase the participation of young women in STEM-related TVET courses, which stakeholders widely referred to as a traditionally male-dominated field. Thus, the National TVET Strategic Plan provided an agenda that was more inclusive and targeted than the ESP 2010–2020. It aimed to produce a capable, driven, malleable and skilled workforce perceived as necessary to propel economic development. Therefore, the National TVET Strategic Plan introduces the use of gender-inclusive approaches that brought the participation of young women in STEM-related TVET courses to the forefront of TVET policy discourse. This policy direction chimes with research on STEM representation that has shown that the use of inclusive and neutral materials in schools makes STEM more inclusive for all genders and is significant in demystifying stereotypical portrayals of STEM (Kendall, 1999; Kerkhoven et al., 2016; Steinke, 2017).

3.2.3 Education Strategic Plan 2018–2030 (2018)

The ESP 2018–2030 is the current national Education Strategic Plan, replacing ESP 2010–2020. The ESP 2018–2030 was designed under a new male Minister of Education, Hon. Martin Opoku Prempeh, as part of a new government led by the New Patriotic Party. The general policy plans of the ESP 2018–2030 were to enable Ghana to achieve the Targets of SDG 4 and represent a deliberate reorientation towards this aim. The plan sets out Ghana’s long-term vision. It outlines how this will be operationalised in the “medium term through the accompanying Education Sector Medium Term Development Plan 2018–2021” (Ministry of Education, 2018b, p. ii). The ESP set a long-term inclusive vision for Ghana’s education sector and defined strategies to operationalise the agenda in alignment with SDG 4. The policy document seems informed by extensive equity, system capacity, cost, and financial analysis. Table 3.4 outlines more inclusive access to TVET compared to the ESP 2010–2020 and the National TVET Strategic Plan. Thus, the ESP 2018–2030 provides an overarching education policy that is inclusive, identifies specific target problems and provides solutions for those problems in the TVET sector.
Table 3.4: Practical Argumentation of the Education Strategic Plan 2018–2030

<table>
<thead>
<tr>
<th>Practical Argument</th>
<th>Extract</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circumstantial premise</td>
<td>“The participation of women in this sub-sector is meagre, especially in traditionally male-dominated areas such as engineering and construction: 26% of female enrolment was registered for 2015/16. Only 18% of females are enrolled in male-dominated occupational areas” (p. 41).</td>
</tr>
<tr>
<td>Goals premise</td>
<td>“Increased enrolment of all categories of learners, including females in TVET. Improved learning outcomes for all, especially girls in all subjects, and for all in STEM subjects” (p. 41). “By 2030, eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, Indigenous peoples, and children in vulnerable situations” (p. 133).</td>
</tr>
<tr>
<td>Value premise</td>
<td>“To provide relevant education emphasising science, information, communication, and technology to equip individuals for self-actualisation, peaceful co-existence, and skills for the workplace for national development” (p. 14)</td>
</tr>
<tr>
<td>Means-goal premise</td>
<td>“Invest in improving learning outcomes for girls in all subjects, especially STEM” (p. 36). Introduce demand-driven programmes offered in mixed modes to respond to the needs of part-time and full-time learners” (p. 41). “Promote science and technical education in basic schools, particularly for girls” (p. 124). “Popularise and demystify the teaching and learning of STEM and ICT education in basic secondary education” (p. 124). “Improved learning outcomes in STEM subjects and overall learning outcomes for girls” (p. 133).</td>
</tr>
</tbody>
</table>

Source: Author
Noticeably, the ESP 2018–2030 can be seen to discursively focus on the participation of young women in STEM-related TVET courses. Thus, out of the three national education policy documents discussed so far, it is the only one that outlines specific circumstantial premises that show a more significant concern for the under-participation of young women in STEM-related TVET courses (see Table 3.4). For instance, it appears to be the only education policy showing statistical evidence that “only 26% of female enrolment was registered for 2015/16. In Senior High Technical Schools, this number was just 11% in 2016/17. Only 18% of females are enrolled in male-dominated occupational areas” (Ministry of Education, 2018a, p. 41).

The additional statistical analysis provided in the report brought about a deeper grasp of the problem and set a seemingly well-targeted agenda that expands what had been discussed in the ESP 2010–2020 and the National TVET Strategic Plan 2015–2025. For instance, the ESP 2018–2030 had a theory of change for the TVET sector (see Figure 3.3). One of the intermediate outcomes of the theory of change is to improve access to relevant TVET courses, which has already been discussed as improving females’ access to STEM-related TVET courses.

**Figure 3.3:** Theory of Change of the Education Strategy Plan 2018–2030

Source: Ministry of Education (2018a, p. 45)
Additionally, the policy plan, as shown in Table 3.4, articulated six specific means-goals that provide means to ensure girls participate in STEM and TVET. These were unique perspectives that had not been discussed in the two policy documents analysed earlier. The general discourse in the plan shows STEM-related TVET courses discussed as relevant to development. In contrast, the National TVET policy document aimed to improve gender mainstreaming and ensure gender-neutral materials in new competency-based training materials. The ESP 2018–2030 includes specific measures such as “promote science and technical education in basic schools, particularly for girls and popularise and demystify the teaching and learning of STEM and ICT education in basic secondary education” (Ministry of Education, 2018a, p. 124). This policy document was explicit about the need for young women to participate in STEM-TVET. It outlines measures to address the under-participation of young women in STEM-related TVET courses.

### 3.2.4 From Prejudice to Prestige: Vocational Education and Training in Ghana (2011)

From Prejudice to Prestige: Vocational Education and Training in Ghana is one of the earliest National TVET reports produced by the City & Guilds Centre for Skills Development and the then Council for TVET. The report, authored by three male researchers at the Centre for Social Policy Studies, University of Ghana (Aryeetey et al., 2013), showed that the primarily TVET policy discourse was about the mismatch between demand and supply and the unattractiveness of TVET among young people. The report was based on focus group discussions with actors in the informal and formal sectors, including learners in the Greater Accra and Eastern regions of Ghana. The interviewees used in the study reported were selected based on evidence that they were either responsible for the training or recruitment of graduates or in frontline policymaking in relevant ministries and departments. A total of 243 respondents were interviewed in focus group discussions across the various stakeholders, and seven significant informants were selected for in-depth interviews. Figures 5.2, 5.3, 5.4, 5.5 and 5.6 show the trade areas investigated in this research report. Figures 5.2, 5.3 and 5.4 show trade areas in fashion and design, cosmetology, and hairdressing, respectively, and these Figures present only females, who are discussed as the dominant participants in these trade areas. Figures 5.5 and 5.6 show trade areas in welding and auto mechanics, respectively. These Figures presented only males, which to a significant extent confirms the narrative that men and boys dominate these trade areas and perhaps also cements the stereotype that these trade areas are preserved for boys and men.
**Figure 3.4:** Two Women with a Sewing Machine Representing the Dressmaking Trade

Source: Aryeetey et al. (2011, p. 15)

**Figure 3.5:** A Group of Women with Neatly Laid Beds Representing the Cosmetology Trade

Source: Aryeetey et al. (2011, p. 20)
**Figure 3.6:** A Group of Women Styling the Hair of Other Women Representing the Hairdressing Trade

Source: Aryeetey et al. (2011, p. 28)

**Figure 3.7:** A Group of Men Working on a Metal Pole, Representing the Welding Trade

Source: Aryeetey et al. (2011, p. 18)
Although the report targeted sectors like construction, electronics, and automotive engineering, which are trade areas that young women do not commonly participate in, the report failed to identify and define the under-participation of young women in STEM-related TVET courses as a problem. The circumstantial premise in Table 3.5 reports a problem that showed an ineffective TVET system. However, from the Figures above, it appeared that the report presented a discourse that entrenched the gender divide in TVET by using biased and stereotypical images. It was different only in two instances: the first, where a woman trainer was seen with other men at what appeared to be an auto workshop and the second, where a young woman was shown attending to a car.

Thus, while the general unequal access to TVET among young women was documented in the report, the TVET policy discourse did not focus on the under-participation of young women in STEM-related TVET courses. The discourse was centred on making TVET attractive and a credible alternative to general education for young people in Ghana. Hence, because there was no acknowledgement of the under-participation of young women in STEM-related TVET courses as a policy concern, it was impossible to use the practical argumentation structure for a problem–solution analysis of the document.
Table 3.5: Practical Argumentation of From Prejudice to Prestige: Vocational Education and Training in Ghana

<table>
<thead>
<tr>
<th>Practical Premise</th>
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<tbody>
<tr>
<td>Circumstantial premise</td>
<td>“There are a variety of challenges affecting the effectiveness of the TVET sector, both in Ghana and internationally, which are widely accepted. Some key challenges include mismatches between acquired skills and market needs, widespread concern about poor quality training and training environments, and negative public attitudes and perceptions regarding vocational education and training” (p. 12).</td>
</tr>
<tr>
<td>Goals premise</td>
<td>“With the initiation of the new Council for Technical and Vocational Education and Training (COTVET) in Ghana, it is imperative to understand the nature of these attitudes and perceptions to be able to target effective interventions which will improve and promote the sector” (p. 12).</td>
</tr>
<tr>
<td>Value premise</td>
<td>“The study is intended to provide a snapshot of the effectiveness of the current TVET system and draw out generalities in terms of the perceptions of training, its issues, and any barriers to developing TVET within the Ghanaian context. Further, the study restricts itself to discussing formal and informal TVET systems and does not consider non-formal provisions” (p. 12).</td>
</tr>
<tr>
<td>Means-goal premise</td>
<td>“Conduct a promotional campaign to improve perceptions of TVET” (p. 8)2 “Develop the careers advice and guidance system” (p. 8). “Expand the policy and legislative platforms for TVET” (p. 9). “Improve the links between industry and training” (p. 9). “Expand the policy and legislative platforms for TVET” (p. 9) “Capacity training for master craftsperson should be introduced” (p. 9). “Improve the links between industry and training” (p. 9).</td>
</tr>
</tbody>
</table>

Source: Author
Nevertheless, some of the suggested means-goals in Table 3.5, such as “conduct a promotional campaign to improve perceptions of TVET and develop the careers advice and guidance system” (Aryeetey et al., 2011, p. 8), were relevant to address some of the gender concerns in TVET. For instance, the CTVET officer interviewed explicitly stated that the recommendation from this report on the use of campaigns had directed the commission’s MyTVET campaign:

We are currently looking for sponsorship to do another report because it has been a while, it has been ten years, and we are looking for an opportunity to do that for general perception on TVET. So, we are still exploring the opportunity to have another report. This report recommended the MyTVET campaign that we are currently rolling out. It did not recommend the MyTVET campaign; I renamed it that. Still, among the key recommendations, the report recommended that you institute career guidance and counselling in junior high schools and have a national campaign tackling negative TVET perceptions and stereotypes. It also recommended improving the links between industry and training. (CTVET Director)

Although this report was the only one based on empirical research, it did not have the language to generate a discourse that positioned the under-participation of young women in STEM-related TVET courses as a TVET problem. It, therefore, suggests generalised means-goals that focus on making TVET attractive. It appeared that the report had divided TVET into two areas, with one category of TVET for girls and the other for boys, especially by presenting STEM areas as a preserve for boys based on the pictures portrayed throughout the report.

3.2.5 Women in TVET: Input into Ghana’s COTVET Gender Strategy Dialogue for the Global Learning Centres (2013)

The report on women in TVET shows that by 2013, a discourse about women’s ‘under’-participation in STEM-related TVET courses was emerging as a policy agenda. For example, the first report presents the discussions on the first-ever women in TVET conference in Ghana. It appeared that the report was the first TVET report in the MDG and SDG era to explicitly discuss the under-participation of young women in STEM-related TVET courses. According to Gloria Morgan (2013), the report was based on the Council of Technical Vocational Education and Training brainstorming session with Ghana’s various TVET authorities. The session focused on four main questions:
1. What are the existing policies/strategies for women’s skills development in Ghana?
2. What are the key elements to consider in developing a gender strategy?
3. Who are the key persons and institutions that should be involved?
4. What steps should we take to develop a gender strategy? (Morgan, 2013)

Morgan gave an overview of this emerging discourse in *Women in TVET: Input into Ghana’s COTVET Gender Strategy Dialogue* for the Global Learning Centres. The report consolidated a dialogue between stakeholders on strategies to increase women’s participation in STEM-related TVET, described as non-traditional or male-dominated fields.

Unlike the previous policy report, this report presented a practical argumentation perspective that discussed the problem, the value proposed by the stakeholders, how to address the problem, the desired change, and the consequences of actions. Table 3.6 outlines the four practical argumentation premises used to propose a problem–solution perspective on the under-participation of women in STEM-related TVET fields in Ghana. It appeared that young women’s under-participation in STEM-related TVET courses had always been a problem. However, it was missing from Ghana’s TVET policy discourse and agendas, especially an inclusive TVET policy approach that targeted young women. For instance, the circumstantial premise of Table 3.6 provides a premise understanding of the problem, which leads to an immediate goal premise target to train young women for STEM fields that lack women.

Although there was a discourse on young women’s participation in STEM-related TVET pathways, Morgan’s report had a narrow value premise that proposed strategies for purely human capital development for national economic growth and not towards realising young women’s aspirations and capabilities. Ghana’s shortage of skilled labour forces has typically been known as a policy concern. However, this did not necessarily include discussions of young women as social agents who needed to participate in STEM-related TVET pathways for their subjective values and development. For instance, as stated in Table 3.6, Morgan explained that the immediate TVET policy target is for Ghana to become “globally competitive with skills in to reduce poverty, reach gender parity, and move Ghana toward a developed country status, will by necessity include women in non-traditional careers as well as men” (Morgan, 2013, p. 1). The statement appeared to portray women as resources for Ghana’s development, which in itself is not bad, but the participation of young women, as reiterated throughout this chapter goes beyond the productivism approach to TVET; thus, women should first study STEM for their value.
Table 3.6: Practical Argumentation of Women in TVET: Input into Ghana's COTVET Gender Strategy Dialogue

<table>
<thead>
<tr>
<th>Practical Premise</th>
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<tr>
<td>Circumstantial premise</td>
<td>“Women lag far behind men in enrolment in and graduation from formal training programs that would afford them the skills necessary to go into highly lucrative technical fields traditionally reserved for men that will help the country develop” (p. 10).</td>
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<tr>
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<td>“Less than 1% of the students enrolled in the lucrative technical courses are female. Overall enrolment figures show that females comprise less than 2% of those taking advantage of training” (p. 10).</td>
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<tr>
<td></td>
<td>“TVET is generally gender-biased, underachieving, and lacking in innovation” (p. 22).</td>
</tr>
<tr>
<td>Goals premise</td>
<td>“Training women to fill the technical occupations to close the skilled worker's gaps would be an admirable goal of the appropriate government sectors and a priority objective for the local district government in light of the Millennium Organizations, development goals designed to improve the living situations of Africa’s poorest populations” (p. 16).</td>
</tr>
<tr>
<td>Value premise</td>
<td>“The development of globally competitive skills in lucrative careers, in the effort to reduce poverty, reach gender parity, and move Ghana toward a developed country status, will by necessity include women in non-traditional careers as well as men” (p. 1).</td>
</tr>
<tr>
<td>Means-goal premise</td>
<td>“Adjusting the problem of women’s nonparticipation requires understanding the issues by examining the root causes” (p. 13).</td>
</tr>
<tr>
<td></td>
<td>“An analysis of these gender-conscious issues - whether cultural, social, or political - will bring to the forefront strategy formulation to move women forward” (p. 13).</td>
</tr>
<tr>
<td></td>
<td>“Achieving gender parity is not only a worthy goal but one that will prove to pull Ghana up from developing country status to a developed nation as the middle class continues to grow” (p. 16).</td>
</tr>
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</table>
“Addressing the issue of eliminating gender barriers includes implementing basic structural changes in the training for trainers (advocating more female teachers and trainers), curriculum development, changing teaching methods, improved classroom and workplace atmospheres, and the greater involvement of males in traditionally female fields of TVET. Furthermore, there is an emphasis on the urgently needed instruments for gender-related quality standards and directives for monitoring and evaluating progress” (p. 22).

Source: Author
Moreover, there was a centralised discourse to ensure that Ghana achieved its gender parity goal. For instance, the means-goal premise clearly showed measures that targeted inclusivity through reaching gender parity. The third means-goal discusses “that achieving gender parity is a worthy goal and will prove to pull Ghana up from developing country status to a developed nation as the middle class continues to grow” (Morgan, 2013, p. 16). Again, the problem is that the policy target was not approached from an inclusive and capability perspective. Although achieving gender parity and economic development are relevant, they are not the only values for increasing young women’s participation in STEM-related TVET courses.

The centralised discourse to ensure that Ghana achieves its gender parity goal is depicted in Figures 3.9 and 3.10. These Figures show images used to communicate the relevance of empowering young women in Ghana. The famous phrase used by many young women in the study and noted in Figure 3.10 was that women could do anything. This simple phrase carries considerable significance to the girls and women who use it, signalling a change in the traditional social and cultural status quo that defines what women can and cannot do. The images of Her Excellency Ellen Johnson Sirleaf and Ghana’s former first lady Nana Konadu Agyeman Rawlings, do not convey direct STEM-related TVET participation. Nonetheless, their images are iconic, conveying information about women’s empowerment and a change in the status quo of women and what girls can become in the future.

**Figure 3.9:** Example of Advertisement for STEM-Related TVET Courses Offered for Young Women

Source: Morgan (2013, p.26)
Figure 3.10: Images Communicating the Capabilities of Women and Girls: Changing the Status Quo

Source: Morgan (2013, p. 25)

3.2.6 Demand and Supply of Skills in Ghana: How Can Training Programs Improve Employment and Productivity? (2014)

This report was authored by two non-Ghanaians who had significant experience with Ghana’s education sector and presented an extensive overview of the general provision (supply) and use (demand) of skills in Ghana. It discusses the overall state of Ghana’s TVET. The authors used the Framework for Skills Assessment for this purpose. As shown in Figure 3.11, it provides a comprehensive structure to study the impact of skills development. What is worth noticing is the impact beyond macro-level components, such as the economy, to more micro-level impact at the individual level. In this regard, the authors approached their discussion from the particularity of individual youth needs, including the needs of young women. For example, the report recommends a means-goal that suggests the provision of specific scholarships that target young women and encourage them to choose trades that traditionally do not employ women (see the mean-goals section in Table 3.7).
Additionally, the report contributed to the growing discourse concerning the under-participation of young women in STEM-related TVET courses. Table 3.7 shows that the report explicitly identified this as a problem. The circumstantial premise expressed the under-participation of young women by explaining how socio-cultural and traditional pressures direct women to “traditionally female trades in both the formal TVET system and the informal apprenticeship system, giving them fewer opportunities to access more dynamic and emerging areas of study such as electronics, information, and communication technology (ICT), and auto mechanics” (Darvas & Palmer, 2014, p. 52). Therefore, the report set specific targets to increase young women’s participation in STEM-related TVET courses, mainly through scholarships and reduction in training costs. These approaches had not been discussed in other policy plans. For instance, the means-goal premise suggests a critical solution: “a targeted scholarship scheme could promote access to TVET, especially for the poor, and for women, who could be enabled to enter trades that traditionally do not employ females” (Darvas & Palmer, 2014, p.8).

However, their report fails to look at aspirations and values. For instance, the value premise, shown in Table 3.7, is mainly for economic growth and to meet productivity demands. They argue:
Developing skills for continued competitiveness, growth, and prosperity is one of the country’s critical new frontiers. The right skills matter at many levels: equipping young Ghanaians to find or create well-paying jobs, helping the private sector to become more productive and, ultimately, ensuring that the economy diversifies and that productive jobs are created in labour-intensive sectors. Ghana’s economic growth is linked to mining and commodities, which account for a relatively low share of employment (Darvas & Palmer, 2014, p.xi).

Besides economic productivity, young women’s value for STEM-related TVET courses and their aspiration to work in STEM-related TVET careers can define the value premise for why young women should participate in STEM-related TVET courses and careers.
Table 3.7: Practical Argumentation of Demand and Supply of Skills in Ghana: How Can Training Programs Improve Employment And Productivity?

<table>
<thead>
<tr>
<th>Practical Premise</th>
<th>Extract</th>
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| Circumstantial premise | “A more rigorous social profiling of the country’s youth is required to develop and deliver different training (and complementary) interventions. Better targeting is required. A well-targeted and well-designed program can contribute to a public good” (p. 8).  
               | “Information is often lacking on what skills are demanded by the labour market (as well as what skills are likely to be in demand in several years). Individuals, therefore, are usually not able to select training courses or specialisations based on current or projected needs; instead, they revert to dominant perceptions regarding trade areas, rely on family and social connections to suggest areas, or—for women—they simply end up going into trade areas that are deemed suitable for their gender” (p. 23).  
               | Sociocultural and traditional pressures steer women to traditionally female trades in both the formal TVET system and the informal apprenticeship system, giving them fewer opportunities to access more dynamic and emerging areas of study such as electronics, information, and communication technology (ICT), and auto mechanics” (p. 52).  
               | “Overall, most male informal apprentices train in traditionally male trades (for example, carpentry, auto mechanics, welding), whereas young women have fewer opportunities in apprenticeship; those opportunities that do exist for women are usually in traditional trade areas for which the market demand is often limited” (p. 163). |
Goals premise
“Ghana’s technical and vocational education and training (TVET) sector is at the intersection of these opportunities and challenges. The TVET sector is tasked with building human capital, helping youth find jobs, and raising labour productivity—but it is often unable to live up to these expectations” (p. xi).
“This report assesses the economic and social demand for vocational skills and the scope and scale of supply; and looks at various institutions, policies, and financing mechanisms. The report also pays special attention to vocational training for those working in the informal economy and non-formal (private) training providers and analyses new initiatives and policies. It demonstrates that various market failures constrain demand for vocational skills by employers and addressing these requires policies that effectively stimulate increased demand for skills in the private sector” (p. xi).

Value premise
“Developing skills for continued competitiveness, growth, and prosperity is one of the country’s important new frontiers. The right skills matter at many levels: equipping young Ghanaians to find or create well-paying jobs, helping the private sector to become more productive and, ultimately, ensuring that the economy diversifies and that productive jobs are created in labour-intensive sectors. Ghana’s economic growth is linked with mining and commodities, which account for a relatively low share of employment” (p. xi).

Means-goal premise
“A targeted scholarship scheme could promote access to TVET, especially for the poor, and for women, who could be enabled to enter trades that traditionally do not employ females” (p. 8).
Improving access to and completion of a quality JHS education will help to make access to post-JHS TVET programs more equitable. Policies and initiatives related to reducing direct and opportunity costs of training will also help” (p. 8).

Source: Author
3.2.7 MyTVET Campaign Report (2020)

The final relevant TVET policy report of interest was the MyTVET Campaign Report. The MyTVET campaign was intended to tackle the misconceptions about TVET and promote an inclusive TVET system. The main component of the initiative is to assist students in JHS in identifying their interests and capabilities in TVET through various activities to achieve their potential. Figures 5.10, 5.11 and 5.12 show the implementation strategies associated with the MyTVET campaign. For instance, Figures 5.11 and 5.12 are sample career guidance books to be made available for JHS students to guide them choose various TVET pathways.

Table 3.8 presents the practical argumentation of the MyTVET Campaign Report. The report discusses the strategy adopted by the CTVET to address the under-participation of young women in STEM-related TVET courses. Although the value premise, as stated in Table 3.8, is to industrialise Ghana’s economy, the means-goals of this report evolved to have an additional focus on the participation of young women in STEM-related TVET courses. For example, by providing guidance and counselling and a role model approach. The use of guidance, counselling, and role modelling to increase young women’s participation in STEM-related TVET courses has not been the focus of the means-goal in the previous strategic plans and reports. The report shows that the CTVET is trying other methods to address the problem. Figure 3.12 on page 84, for instance, shows how CTVET uses social media to reach more young women. It provides a link that takes young people to a YouTube channel with videos of testimonies from young women working in STEM-related TVET fields.
### Table 3.8: Practical Argumentation of the MyTVET Campaign Report

<table>
<thead>
<tr>
<th>Practical Argument</th>
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<tbody>
<tr>
<td>Circumstantial premise</td>
<td>“Despite the available opportunities and prospects in the world of work, information about them is still not known to the teeming youth. This undermines the ability of the youth, especially young women and their parents or guardians, to make informed and appropriate decisions regarding career choices. This challenge has a critical implication for skilled labour security in Ghana” (p. 1).</td>
</tr>
<tr>
<td>Goals premise</td>
<td>“Inspire world-class excellence in skills development and introduce the youth to a variety of skilled careers, using such tools as the National Skills Competition, TVET clubs in Junior High Schools, Career Guidance Counselling, and the use of TVET Ambassadors and Role Models” (p. 1).</td>
</tr>
<tr>
<td>Value premise</td>
<td>“The new government policies to industrialise the economy of Ghana” (p. 1).</td>
</tr>
<tr>
<td>Means-goal premise</td>
<td>“Encourage girls to enter male-dominated trade areas and professions. Make available much-needed information on TVET to students. Improve Guidance and Counselling structures in schools” (p. 10). “Guide students to acquire knowledge, skills, and experience in TVET” (p. 10). “Inspire students to explore TVET by exposing them to TVET role models who are individuals of high standing in society and excelled in various TVET careers. Increase enrolment of students in TVET institutions” (p. 10).</td>
</tr>
<tr>
<td>Claim premise</td>
<td>“There is the need for a precise strategic instrument to attract more youth into TVET to ensure a national balance between opportunities in the world of work and capabilities or skills residing in Ghana’s human resources” (p. 1).</td>
</tr>
</tbody>
</table>

Source: Author
Figure 3.12: Picture of Social Media Advertisement for MyTVET Campaign

ctvetgh WOMEN IN TVET - “... Don't put your mind on one career path like sewing or hairdressing. Divert your minds into male dominated roles. There is a lot of money.”

Eileen Antwi, an auto mechanic says she has achieved her goal through TVET. #chooseTVET.

Watch the full video here 👉 https://youtu.be/k9nPQhsqD54

#CTVET #TVET #ichooseTVET #skillstraining #education #skills #rolemodel

Source: CTVET Instagram Page
Figure 3.13: TVET Guidance and Counselling Book on Transportation, Processing, and Related Careers

Source: Author

Figure 3.14: TVET Guidance and Counselling Book on Information and Communication Technology Careers

Source: Author

3.3 Conceptualising Ghana’s TVET Policy Discourse from 2010–2030

The overviews of the policy documents and the practical argumentation extracts based on the CDA, revealed how Ghana’s TVET policies about the under participation of young women in STEM-related TVET has evolved between 2010 and 2020. The evidence suggest that main
discourses draw inspiration from global TVET trends as discoursed in Chapter two. For instance, Ghana’s TVET discourses have evolved from human rights-based argument in 2010 to human capital approach with a gradual shift to focus on more sustainable development agenda in 2018. These dynamics appeared to influence how Ghana’s TVET policies were framed and how these policies impacted the participation of young women in STEM-related TVET. Therefore, I now turn to analysis the dominating discourses in Ghana’s TVET policy and how they translated into the practices the defined the participation of young women in STEM-related TVET in technical schools (Amegah, 2022).

First it appeared that Ghana had a delayed discourse about the under participation of young women in STEM-related TVET. Thus, Ghana’s TVET policy delayed in making the participation of young women in STEM-related TVET a policy agenda. The delayed discourse appeared throughout the circumstantial premises discussed in the policy documents until 2013 (Morgan, 2013). Although the under-participation of young women in STEM-related TVET courses was always a problem, it was not prioritised as a policy discourse because the focus on access through the right to education rather than focusing of which TVET areas where young women failing to access(McGrath et al., 2020). The seeming delay in setting policy agenda to increase the participation of young women studying STEM-related TVET courses cannot be explained by the current data. Yet it is possible to argue that the era of Millennium Development Goal on education which proposed a blanket human rights approach to education access appeared to be the foundation of most education policies that prioritised gender parity in enrollments without specific aim of how young people flourished through different forms of education (UESCO, 1996). As discussed in Chapter two the over emphasise on human rights approach did not allow most countries to concentrate on other needs of education (Misola, 2010).

One of the reasons why this explanation is possible is because of the consistent use of a gender parity lens to discuss the under-participation of young women in STEM-related TVET courses. The discursive practice of simplifying the problem premise through a limited gendered perspective appeared to rob the essence of prioritising the under participation of young women in these STEM-related TVET courses. The gendered perspective has made it seem that young women only have to participate in STEM-related TVET courses to catch up with young men who already dominate STEM-related TVET courses. The essence of the problem has been simplified to one of gender parity in participation rates (Nussbaum, 2003; Powell, 2012; Walker, 2005; Walker & Unterhalter, 2007).
Another concern is that most the values were limited to human capital and economic development at the national level, at the expense of young women as individual citizens with distinct capabilities. For instance, the National TVET Strategy Policy aligned its overall value for “transforming TVET to developing a world-class industry-led TVET system that prepares a globally competitive workforce for Ghana’s social and economic transformation” (COTVET, 2016, p.iii). The ESP 2018–2030 outlined some individual levels TVET goals with an “emphasis on science, information, communication, and technology to equip individuals for self-actualisation, peaceful co-existence, and skills for the workplace for national development” (Ministry of Education, 2018, p. 14). Despite the mention of individual-level development, such as self-actualisation through science and technology, the value is broadly developing a human workforce for national development. This national development agenda through human capital development is further emphasised in the MyTVET Campaign Report, which stated, “the new government policies to industrialise the economy of Ghana” (Opare, 2021, p.1). The human capital and the economic growth agenda for TVET, including women’s participation in STEM-related TVET courses, was problematic because the productivism agenda does not prioritise learners’ critical capabilities and voices as central needs of policy strategies (McGrath, 2012b; Powell, 2012).

Overall, the use of human capital as a TVET policy appeared to be a common narrative across the literature and the idea of productivism as the value of TVET has dominated most TVET policy agendas (Bonvin, 2019; DeJaeghere & Baxter, 2014). The core argument of the human capital value of TVET as discussed in Chapter two is that technical and vocational graduates have acquired skills and competencies that meet labour market demands for productivity and economic outcomes. Therefore, most countries align TVET with national competitiveness, national development, national productivity, and national economic growth. Human capital value has dominated the global TVET agenda, mainly for developing countries, including Ghana (Darvas & Palmer, 2014). For example, Arum and Shavit (1995) found that when human capital values drive TVET, learners who are unlikely to attend college can consequently find employment, which reduces the risk of unemployment and makes TVET a safety net that reduces employment risk. One identified potential strength of the human capital value of TVET has, therefore, been its ability to help countries improve the relationship between social backgrounds and educational outcomes through the utilisation of education to improve social mobility trained citizens. Although there have been variations in education policy directions throughout years, the sustained
commitment to develop human capital through TVET has brought about impressive results and contributed enormously to growth and poverty reduction (Darvas & Palmer, 2014, p. 12).

However, the human capital value of TVET has been critically challenged in the last decade (International Labour Organization (ILO), 2020; McGrath, 2012b; Powell, 2012; Wilson, 2004). These scholars have proposed sustainable development, human development, social justice, and capability values to drive TVET. For example, Hilal (2019) proposes a human development value to drive TVET because, in contrast to the human capital value of TVET, this approach can draw attention to inequalities and marginalisation. These theoretical arguments and criticisms of the human capital value of TVET have led to a new theoretical approach to VET and development. The new theory draws on the human development and capabilities approach (Sen, 1999; Robeyns, 2005). The critical-capabilities approach (CCA) seeks to address the disparities in skills development and the value of TVET to move beyond the narrow focus on immediate employability and production (McGrath, 2012a; Powell & McGrath, 2014). CCA moves beyond the atomised individualism of the traditional human capital approach by doing the following:

1. Developing a far stronger account of agency
2. Expanding beyond early work on capabilities and education by insisting on the importance of structure and power (the word ‘critical’ used); and
3. Influencing the political economy of skills tradition, critical realism, and feminist theory (McGrath et al., 2019).

The human development and capability approach value of TVET brings to light the need to critically consider the voices of young people, especially women who are underrepresented in TVET and STEM. Learners’ voices in expressing their aspirations, expectations of success through meaningful work and their intersectional experience of marginalisation and disempowerment are critical to understanding how TVET can play a transformational role among young people (McGrath et al., 2020). The voices of young women studied have significantly contributed to this new value of TVET.

5.8 Summary

The policy context has showed that there had been a delayed discourse concerning young women’s under-participation in STEM-related TVET courses. Although there has been a gradual prioritisation of the issue as a policy target in recent policy documents, the measures identified by policy executives to solve the problem were limited to improving gender parity, increasing access, and building human capital. However, the discourses about young women’s agency and capability as a value for young women’s participation in STEM-
related TVET courses appeared to be largely missing. It appeared that Ghana is yet to translate the values of the SDG 4 which concentrate on capabilities into full practical outcomes. It appears that although Ghana’s TVET policy agenda articulated the capability approach of human flourishing in recent times, Ghana’s policy practices are still human rights and human capital based. The TVET policy context and the reality of the under participation of young women in STEM-related TVET reveals a disconnection between policy strategies in TVET policy documents and implementation processes.
Chapter 4. Methodology

The purpose of the methodology chapter is to explain and substantiate the underlying assumptions of the research methods that guided the current research and to position these assumptions in line with the philosophy that underpinned the methodology used in the current study. Accordingly, the chapter justifies why qualitative methodologies were essential in investigating the four outlined research questions (RQs). In addition, the chapter reviews the critical tenets of phenomenological philosophy proposed by Heidegger, with which this research is aligned. This section explains why the study of lived experiences was addressed according to Heidegger’s construct, as opposed to being underscored by the ideas of essence proposed by Husserl. I explain how I achieved rigour, transparency, and credibility throughout the processes of data construction and analysis. Finally, the chapter will conclude with a reflexive note on the methodological process, considering its ethical and methodological limitations.

I investigated four core RQs that enabled the co-generation of data with research participants:

1. How do young women pursuing STEM-TVET courses at ISCED Level 3 in Ghana decide to pursue STEM-TVET courses?
2. How do young women pursuing STEM-TVET courses at ISCED Level 3 in Ghana make sense of their experiences as STEM-TVET students?
3. How do young women pursuing STEM-TVET courses at ISCED Level 3 in Ghana describe the effect of pursuing STEM-TVET on their developing identities?
4. How do young women pursuing STEM-TVET courses at ISCED Level 3 in Ghana consider their aspirations?

It is important to note that all four RQs, outlined above, were necessary to extrapolate each of the core research themes, which covered decision-making, lived experiences, identity, aspirations and TVET policy. The RQs are also intentionally framed in the ‘how’ rather than the ‘why’ since they enable the research to focus on the processes that generated these young women's decisions, aspirations and lived experiences. The relevance of framing ‘how’ questions is succinctly captured by Clark (2012, p. 17) as:

The question of how invites us to look closely at the sequences of interactions that produced specific outcomes. By contrast, the question of why invites us to search for remote and categorical causes: imperialism, nationalism, armaments, alliances, high finance, ideas of national honour, and the mechanics of mobilisation. The why approach brings a certain
analytical clarity, but it also has a distorting effect because it creates the illusion of a steadily building causal pressure; the factors pile up on top of each other, pushing down on the events; political actors become mere executors of forces long established and beyond their control.

Therefore, asking ‘how’ questions enabled the generation of narratives replete with agency and action orientation at the individual level. I asked these RQs from a how perspective, which enabled these young women to construct themselves as capable agents with intentional and well-calculated steps to arrive at their current pathway, school, course, and career choice. Thus, the decision to pose ‘how’ questions enabled young women to narrate their journey through events of their lives, bringing them to their current understandings, reasoning, and emotions behind these decisions. Indirectly, posing ‘how’ questions allowed the ‘why’ answers to develop naturally instead of the other way around (Clark, 2012).

The research methodology adopted to answer these questions enabled the research to step into both structure and agency argument (Archer, 2014), where the voices of the young women as individuals, the agencies they yielded and the structural systems that existed were well captured in the findings; these are explored in Chapters 4 and 5. The methodological approach adopted situated the research in a critical realist (CR) conceptualisation of qualitative research (Scott, 2005). Thus, the underlying philosophy of the research questions and methods fundamentally aligned with three core CR assumptions discussed by (Scott, 2005). First, the social constructs and structures, such as education systems and gender roles operating at the individual level, are reflexively monitored; women either act upon these individually or collectively try to influence and change them as both developed and developing structures. Second is the need to concentrate on social performances not determined by social structures. Human beings are knowledgeable persons with agentic powers to create change, and hence, they hold the capacity to observe their functions and change the practical orientations that guide needed actions. The final assumption was that any attempt to develop a specific methodological pathway for this research to describe and explain the lifeworld of young women studying STEM-related TVET courses would inevitably be imperfect. As Scott (2005, p. 635) states, “this is because those ways of ordering the world, its categorisations and the relationships between them, cannot be justified in any absolute sense, and are always open to critique and their replacement by a different set of categories and relationships.”
This kind of methodological paradigm is similar to but different from the constructivist approach, in which individuals are seen to construct their understandings and knowledge of the world through experiences and reflection on those experiences (Adom et al., 2016; Seale, 1999). The CR paradigm moves beyond knowledge construction to the use of theories to help researchers get closer to reality. Mainly the CD uses theory to identify causal mechanisms that drive social happenings, or phenomena, which individuals form from selectively making rational judgements related to these social events (Archer, 2014; Fletcher, 2017). In Fletcher’s (2017, p. 182) words, “the ability to engage in explanation and causal analysis (rather than engaging in the thick empirical description of a given context) makes CR useful for analysing social problems and suggesting solutions for social change.”

4.1 Research Method 1: Interpretative Phenomenological Analysis (IPA)

Answering the four core RQs related to the lived experiences of young women required an interpretive research paradigm for four reasons. First, a qualitative interpretive approach enabled a more intimate and in-depth engagement with the young women studying STEM-related TVET courses in their school settings. This was essential because the environment in which these young women were going to be interviewed – school – was seen as central to their lived experiences of interest, and it was posited that interviewing them in school would generate richer narratives and in-depth engagement. Second, a qualitative interpretive approach allowed the explanation of interviewees’ narratives and perceptions from the participants and the researcher’s perspectives to generate the necessary first- and second-order constructs (Schutz, 1967). Third, this approach allowed the construction of an ongoing conversation between concepts and ideas emerging from the narrative data and those derived from the broader literature, thereby maximising opportunities to generate in-depth meanings and insights from the existing body of knowledge and co-generated knowledge. Last but not least, the approach offered the prospect of developing an individualised level of rapport, which was unique to each interviewee (Levitt et al., 2017; Punch, 2014).

4.1.1 Philosophy of IPA

A phenomenological perspective was also needed to adequately answer the first four QRs since these questions aimed to make sense of young women’s lived experiences and their interpretations of those lived experiences. Thus, the phenomenological approach adopted was necessary to permit a rigorous interpretation of the narratives. Among the family of interpretive research methods that align with phenomenology, interpretative phenomenological analysis (IPA) emerged as the most appropriate research method to adequately address the first four RQs. IPA aligned this research with existential and
hermeneutical phenomenology (Smith et al., 2009). Existential phenomenology enabled the research to concentrate on aspects of concrete human existence like ‘free choice,’ which was relevant to answering questions related to how young women pursuing STEM-TVET courses at ISCED Level 3 in Ghana decide to pursue these courses. Hermeneutical phenomenology, which concerns individuals’ interpretations of their lifeworld (van Manen, 1990), enabled the research to explore how young women made meanings of their experiences. Smith et al. (2009) argue that the existential and hermeneutical perspectives that underpin IPA align with Heidegger’s (1982) explanation that to understand Beings, we must seek to make sense of their experiences. Therefore, conducting IPA research facilitated this meaning-making and interpretation of the lived experiences of the young women studied (Smith et al., 2009).

Smith and Osborn (2008, p. 53) emphasise that “the strength of IPA as a research method lies in its ability to allow research participants to make sense of their personal and social world, and the main currency for an IPA study was the meanings particular experiences, events, states hold for participants.”

In addition, I wanted to consciously use the interviews as a tool to give these young women, who are minorities in STEM-related TVET pathways, a voice. Given this objective, IPA has shown to have the currency to investigate the lived experiences of and give a voice to minority and marginalised groups (Larkin et al., 2006, 2019; Smith et al., 2009; Smith, 2004). Besides, an in-depth analysis of the existing literature on using IPA revealed that IPA has been valuable for research investigating other concepts relevant to the current research. These concepts included decision-making (Kam, 2006; Smith et al., 2002; Wyer et al., 2001), identity and transition (Smith & Osborn, 2007; Vangeli & West, 2012), as in RQs 2, 3 and 4. Thus, IPA was the best approach to answering the first four RQs. Despite IPA being widely used in psychology research rather than education research, it fundamentally positioned the current research to make meaning of experiential processes narrated by young women. It gave these young women a voice to make sense of their lived experiences (Smith et al., 2009).

4.1.2 Limitations of IPA

Despite being the most appropriate research method to address the first four RQs, IPA had three primary limitations. One was the non-generalisability of the findings (Wyer et al., 2001). The generalisability of research findings is relevant in most cases; however, I could not generalise the findings to a substantial context because of the adopted IPA approach. While this was the case, Giorgi and Giorgi (1997) argue that in phenomenological research, generalisation of findings is not paramount; more critical is how these methods guide the
researcher to answer the RQs. Thus, according to this argument, the priority of the research was to answer the five RQs adequately; that is, the emphasis is on internal validity instead of external validity. So, although generalisability was not possible with the IPA method, IPA remained the most appropriate method for the current research.

The second limitation concerned IPA’s alignment with Heidegger’s work and the questionable character of Martin Heidegger in the 1930s. Heidegger’s involvement in the Nazi movement positions his philosophical works in an unsettled debate. Even though there is no evidence that his philosophical works were political, the political consequences of his actions seem to overshadow his philosophical work (Korab-Karpowicz, 2021). Therefore, it has become essential to emphasise that, as much as this research draws on IPA’s existential and hermeneutic philosophy, the research does not align with Heidegger’s controversial political opinions and activities. The research only encapsulates Heidegger’s philosophy of making sense of lived experiences, underpinning the IPA method. Therefore, regardless of the controversies associated with Heidegger, IPA remained the appropriate method for addressing the first four RQs.

The third limitation of the IPA method was its limited opportunity to assess these young women’s narratives objectively. Like other quantitative and qualitative research methods, such as surveys and interviews, it was only possible to generate subjective accounts through interviews. There were limited opportunities to verify the narratives, and only the interviewees could verify the trustworthiness of their narratives. Moreover, interviewee and researcher biases constrained the objectivity of this research. While interviewee bias concerned the non-verifiable subjective experiences and subjective interpretations of the experiences of young women, researcher bias concerned the subjective lens used to interpret the meanings of the narratives.

Further, because these young women had no experience in interviews, I frequently used probes and prompts to guide the interviews. These frequent probes and prompts, which are usual in IPA, helped clear their misunderstandings. Although these prompts and probes are helpful, specific answers by these young women reflected these embedded subjective biases. IPA scholars like Brocki and Wearden (2006) and Smith (1999) admit these shortfalls in using IPA and caution researchers to minimise these potential biases, especially during data generation and analysis. The data collection and analysis sections detail the rigorous measures that guided the data generation and analysis processes to limit these subjective biases. So far, it is evident why IPA was the most suitable research method for this study. The combined functions of phenomenology and interpretation adequately guided the research’s
central facet: investigating the lived experiences of young women studying STEM-related TVET courses.

4.2 Research Method 2: Critical Discourse Analysis

I now turn to the second qualitative method adopted to explore selected education policy documents discussed in chapter 3. The research aimed to speak to powers that oppress certain marginal groups in society, drawing on a social justice research tradition. Therefore, it was crucial to qualitatively understand the structures and powers that perpetuate, reproduce, or transform young women’s under-participation in STEM-related TVET courses at ISCED Level 3 in Ghana. As Aydarova (2019, p. 33) aptly argues:

Social justice research often focuses on underserved and marginalised groups’ voices, experiences, and practices. While this focus produces essential insights, it disregards the actions of those in power who create and maintain systems of inequality and injustice in the first place.

It was necessary to engage with policy education policy documents understand how young education policies conceptualised the ‘under’-participation of young women in STEM-related TVET courses in Ghana. Education policy documents such as TVET reports, education strategy plans and TVET policy documents were the primary sources for the corpus of data extracted for analysis. These education policy documents contained relevant discourses on the problem, the strategies used to address the problem and the values that drove these proposed solutions.

4.2.1 Conceptualising Policy as Discourse

The decision to adopt CDA as the appropriate research method to answer RQ 5 made it necessary to conceptualise policy texts as a form of discourse. This process aimed to afford a realistic approach to analysing policy texts. The notion of policy as discourse has been widely used to assess policy design and processes (Ball, 1990; Ingram & Smith, 1997; Schneider & Ingram, 1993). Scholars, especially Ball (1990), argue that policy discourse concerning education processes and designs is a claim of power and knowledge relationships. He interprets the power and knowledge of education policy to mean that education policy concerns “what can be said and who can speak, when, where, and with what authority” (Ball, 1990, p. 17). Primarily, his argument reflects how powerful educational actors use their positions of power and privilege to determine the design of education policy, implementation and, to a significant extent, the outcomes. What they say with authority and value is reflected in education policies. The core argument is that policy representations “mystify power
relations and often create individuals responsible for their failures, drawing attention away from the structures that create unequal outcomes” (Bacchi, 2010, p. 46).

The core proposition of policy as discourse functions as an expressive process to create “meanings and social relationships which constitute both subjective and power relationships” (Ball, 1990, p. 17). How policy reflect the values regarding the participation of young women in STEM-related TVET courses and how these translated into the education policy arena reflected the subjective and power relationships. This value-laden argument perspective underlies policy design, which is policy content (Ingram & Smith, 1997; Schneider & Sidney, 2009). Ball (1990) further explains that policy as discourse is fundamental to the argument that policy content carries policy designers’ principles, values, and intents. These explanations confirm the centrality of power and control in policy design (Prunty, 1985, p. 136) and the relevance of assessing “whose values do policies validate and whose are not” (Ball, 1990, p. 3). These two questions posed by Ball (1990) were essential to the decision to conduct a critical discourse analysis of the policy text from policy documents.

In order to analyse education policy as a discourse discussed in Chapter 3, a critical analytical method that did not limit policy analysis to rational and normative standards was needed. The method could systematically assess the value-laden assumptions of education policies and further situate the analysis within the value-laden perspective and policy design as a social process (Ingram & Schneider, 2008; Schneider & Ingram, 1993; Schneider & Sidney, 2009). After carefully considering the significant advantage of CDA compared with other discourse analysis methods, such as political discourse analysis, which looks more at political debates rather than social policy issues, CDA was identified as the most appropriate. CDA had the distinct analytical value that enabled the analysis of educational policy discourse within the framework of a structure that answered RQ 5 and situated the analysis in some fundamental policy elements (Ingram & Schneider, 2008).

4.2.2 CDA: Problem–Solution Approach

Although Ball (1990) states that he draws on the notion of discourse in policy analysis from Foucault’s (1981) tradition, the idea of policy as discourse has evolved. Scholars like Fairclough (2013) posit CDA as the new form of this discourse analysis tradition, enabling the scrutiny of policy discourses through a practical argumentation structure. The practical argumentation approach adopted for CDA was to reveal and explain the relationship between policy discourses concerning the under-participation of young women in STEM-related TVET courses as a discursive practice, educational structures and prevailing educational practices. Fairclough (1993, p. 136) argues:
CDA aims to systematically explore often opaque relationships of causality and determination between (a) discussing practices, events, and texts, and (b) why the social and cultural structures relationships and processes; investigate how such practices, events and texts arise out of an ideological issue by relationships of power in struggles over power; and to explore how the opacity of these relationships between discourse and society is itself a factor securing power and hegemony.

The discursive practice construed in policy texts can help create change or preserve social practices and behaviours (Janks, 1997). The basic structure of the practical argumentation process includes five elements: a value premise, a goal premise, a circumstantial premise, a means-goal premise, and a claim or conclusion (Fairclough & Fairclough, 2012).

Other researchers have employed different discourse analysis methods, such as political discourse analysis (PDA), poststructuralist discourse analysis (PDA) and cultural and political economy (CPE) (Bacchi, 2010). The main disadvantage of these methods is their inability to provide a complete sense of the text; they are more closely aligned with political economy. Although CDA fails to conceptualise the challenges of applying the problem–solution approach in different contexts, the approach was well suited for policy analysis for four reasons. First, CDA stems from an anti-positivist and interpretative position of the social deconstruction of policy studies, which aligns with the notion of policy as discourse (Bacchi, 2010). Second, CDA enabled understanding of the relationship between the discourses in policy text, values of policies and power relations (Janks, 1997). Third, the kind of CDA proposed here is the recent version of Fairclough’s discourse analysis tradition, which argues that the central focus of discourse analysis in policy studies should be a problem–solution perspective fundamental to the practical argumentation structure (Fairclough, 2013). Finally, the functions of CDA as a method, particularly the “practical argumentation structure of problems and solutions approach, allow the social deconstruction of policy, making it advantageous over other forms of discourse analysis” (Fairclough, 2013, p. 12).

**4.3 Sampling**

The research engaged two primary populations. The first population of interest comprised young women studying STEM-related TVET courses in Ghana Education Service (GES) upper secondary TVET schools categorised as Technical Institutes (TIs). This population was small and sparsely distributed in GES TIs across Ghana. These young women studied STEM-related TVET courses categorised as elective technical programmes, divided
into five primary groups: engineering, manufacturing, technology, computing, and construction. Figure 4.1 is an example of a computer laboratory used by learners of the computer hardware course in ATI.

**Figure 4.1:** Computer Laboratory for Computer Hardware Practical Lessons

![Image of computer lab](image)

Source: Author

Figure 4.2 is an example of an auto mechanical engineering workshop used by learners in CCTI. These primary groups were divided into sub-groups: automobile engineering, electrical engineering, building and construction technology, air conditioning and refrigeration technology, computer hardware technology, software engineering and solar engineering. These subjects fit the earlier operationalisation of STEM-related TVET courses as TVET courses that “require training in science, technology, engineering and mathematics” (UNESCO-UNEVOC, 2019, p. 1).

**Figure 4.2:** Auto Mechanical Engineering Workshop for Practical Lessons

![Image of auto mechanical workshop](image)

Source: Author
4.4 Access

The access strategy used during the fieldwork followed a structured top-down approach (see Figure 4.3 on page 100). The process involved macro-level, meso-level and micro-level approvals. Despite the uncertainties and the risks of fieldwork, especially face-to-face data collection during a pandemic, I received approval from GES to begin the face-to-face data collection process beginning in January 2021 in three Technical Institutes in the Central region: Asuansi Technical Institute, Cape Coast Technical Institute and Enyan Abaasa Technical Institute. The main reason for selecting the central was a ratio analysis of male and female enrolment in technical courses in all GES TVET schools, as shown in Table 4.1, which showed the region had the highest disparity of a ratio of 59:3 during the 2017/2018 academic year.

I used this approval from GES to secure further approval from the Faculty of Education, University of Cambridge. In Ghana, the next step was to visit the Central region to process additional research approval at the regional, district and school levels. After three weeks of engaging with all the agencies of concern, such as the Central region GES office, the Cape Coast Metropolitan Assembly, Abura Asebu Kwamankese District Assembly, and the Ajumako/Enyan/Essiam District, I received the approval letters and documents.

By the week beginning 25th January 2021, all three schools received additional information and documentation necessary to continue the micro-level approval process after the letters from the macro-level and meso-level agencies. The micro-level approval included submitting informed consent forms to the principals of the schools for consideration. Also, principals received an additional explanation of the research and clarification of potential issues; at this point, I sought access to the young women. The principal asked the principals to permit access because these young women of interest were boarding school students. The principals acted as parents in Ghana’s upper secondary school boarding system (Alhassan, 2013). Nakpodia (2012) explains that within the in loco parentis principle, the assumption is that parents delegate their parental authority to school authorities. School authorities are therefore held responsible for making decisions that are in the children’s best interests. Consent from principals was necessary because the young women in these Technical Institutes were primarily children based on the classification of children according to the United Nations Convention on the Rights of the Child (UNCRC) (Eatough & Smith, 2017). Therefore, like Keaveney et al. (2018), the research followed the principle of in loco parentis, and principals of the Technical Institutes were asked to provide consent for access to the school premises and the young women under their care. Although the process was
bureaucratic, the top-down access approach increased the credibility of the research and limited challenges during the data collection process.

**Figure 4.3: Access Map**

Source: Author

**4.4.1 Sampling Young Women**

In selecting the population of young women sampled, I used a non-random sampling approach (Onwuegbuzie & Leech, 2007). A careful analysis of the strengths and weaknesses of different non-random sampling designs, such as quota sampling, modal instant sampling, and purposive sampling, ensured that a suitable sampling strategy was identified for sampling the participants. The random purposeful sampling method appeared adequate for accessing an ideographic sample (Miles & Huberman, 1994). The random purposeful sampling method involved using one purposeful sampling technique to identify and select an appropriate case for the study. The next step was identifying a simple random method to select the participants from the identified case (Onwuegbuzie & Leech, 2007).

Based on the nature of the population of interest as scarce and sparsely distributed across different Technical Institutes, there was a need to identify a method that allowed the selection of chosen cases from which I could learn the most, and the extreme case sampling
method afforded that advantage. As Robinson (2014) suggests, extreme case sampling techniques make it possible to locate a case that exhibits some distinct characteristics of the phenomenon of inquiry. The second approach was a simple random technique for the final participant sampling from the chosen extreme cases. The combination of an extreme case and random sampling method could increase the validity and credibility of the research (Miles & Huberman, 1994; Onwuegbuzie & Leech, 2007).

Consequently, the sampling began with the extreme sampling technique to select the region with the lowest enrolment rate of young women in STEM-related TVET courses in technical schools. The extreme case served as the frame from which I could learn about the phenomenon of interest. Analysis of current upper secondary TVET enrolment data as extreme sampling criteria revealed the Central region with the most extreme case of the phenomenon of interest. Ratio analysis of male and female enrolment in technical courses in all GES TVET schools, as shown in Table 4, shows the Central region had the highest enrolment disparity in STEM-related TVET pathways between boys and girls with a ratio of 59:3 of boys to girls during the 2017/2018 academic year.

**Table 4.1: Gender Inequality in TVET and STEM-TVET Enrolment per Region**

<table>
<thead>
<tr>
<th>Region</th>
<th>Boys</th>
<th>Girls</th>
<th>Boys: Girls</th>
<th>Boys</th>
<th>Girls</th>
<th>Boys: Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashanti</td>
<td>4,420</td>
<td>372</td>
<td>11:9</td>
<td>5432</td>
<td>370</td>
<td>14:7</td>
</tr>
<tr>
<td>Brong Ahafo</td>
<td>2555</td>
<td>451</td>
<td>5:7</td>
<td>2366</td>
<td>198</td>
<td>11:9</td>
</tr>
<tr>
<td>Central</td>
<td>3502</td>
<td>484</td>
<td>7:2</td>
<td>3083</td>
<td>52</td>
<td>59:3</td>
</tr>
<tr>
<td>Eastern</td>
<td>5628</td>
<td>926</td>
<td>6:1</td>
<td>4946</td>
<td>455</td>
<td>10:8</td>
</tr>
<tr>
<td>Greater Accra</td>
<td>8473</td>
<td>1531</td>
<td>5:5</td>
<td>2750</td>
<td>206</td>
<td>13:3</td>
</tr>
<tr>
<td>Northern</td>
<td>3748</td>
<td>2455</td>
<td>1:5</td>
<td>1645</td>
<td>38</td>
<td>43:3</td>
</tr>
<tr>
<td>Upper East</td>
<td>4140</td>
<td>1508</td>
<td>2:8</td>
<td>1546</td>
<td>67</td>
<td>23:1</td>
</tr>
<tr>
<td>Upper West</td>
<td>2061</td>
<td>428</td>
<td>4:8</td>
<td>1238</td>
<td>76</td>
<td>16:3</td>
</tr>
<tr>
<td>Volta</td>
<td>5121</td>
<td>1422</td>
<td>3:6</td>
<td>4260</td>
<td>161</td>
<td>26:5</td>
</tr>
<tr>
<td>Western</td>
<td>4653</td>
<td>308</td>
<td>15:1</td>
<td>2417</td>
<td>52</td>
<td>46:4</td>
</tr>
</tbody>
</table>

Source: Ghana Education Service EMIS Data

The second step was a simple random sampling technique for selecting young women from the three GES Technical Institutes. The process involved setting up the selection criteria, which were as follows:
1. The young woman must be a full-time registered student at the school.
2. The young woman must be taking a STEM-related TVET course.
3. The young woman must be willing to engage in the interview process.
4. The young woman must be in her first, second or final year of studies.

The purpose of random selection was to reduce the chance of selection bias from the heads of departments who were interested in helping with the selection of young women—using the selection criteria, the heads of departments of STEM-related courses in engineering, construction, computer systems and technology selected the young women for interviews. The same selection criteria were applied in all three schools because of the small size of the population.

Ideally, the simple random technique would have involved young women in each year group on a particular course picking random numbers, and those who selected even numbers formed the research sample. However, there was one contextual challenge to the randomisation process. Thus, there were courses with only one female student. Therefore, in those cases, the young woman automatically became part of the sample after giving their consent. For instance, in CCTI, there was only one final-year young woman in mechanical engineering, so the department head conveniently invited her to join the sample group. The contextual challenges posed a threat to the credibility of the simple random sample technique; nonetheless, the simple random sample process aided the credible selection of most young women.

Finally, one meaningful change in the sampling process was the inclusion of a fourth Technical Institute located in the Northern region of Ghana. While the Northern region of Ghana was not the initial focus of the research, it became evident that no young women from the Northern region were included in the sample selected in the Central region. The young women sampled from the Central region schools came from other regions, such as Greater Accra, Western, Ashanti, Volta and Brong Ahafo. A reference to Table 4.1 shows that this was possible because even in the Northern region, only 38 girls were enrolled in STEM-related TVET courses. Hence, it was necessary to include at least one Technical Institute in the Northern region to increase the narratives' diversity and the sample size. The selected school was recommended by one of the education policy officials, who subsequently granted access to the Institute for research purposes.

4.4.2 STEM-TVET Distribution and Sample Demographics According to Schools

The STEM-related TVET course enrolment demographics show the descriptive data regarding the male-to-female enrolment in STEM-related courses in each school studied for
the research. Participants’ demographic details account for the background of these young women using age, region, course, parent’s education and economic status, Basic Education Examination Certificate (BECE) and school year. The enrolment data for STEM-related TVET courses shows that each school offered different STEM-related courses; however, courses like electrical engineering and mechanical engineering were shared across the four schools. The tables further show current data on the gendered enrolment records for each school, which confirm gender disparity in STEM-related TVET across the schools. An additional table on sample demographics provides additional contextual details about the participants.
### Table 4.2: Third-Year STEM-Related TVET Enrolment According to Gender

<table>
<thead>
<tr>
<th>STEM-related TVET Courses</th>
<th>Female Enrolment</th>
<th>Male Enrolment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor Vehicle Engineering</td>
<td>0</td>
<td>66</td>
</tr>
<tr>
<td>Welding and Fabrication Technology</td>
<td>1</td>
<td>63</td>
</tr>
<tr>
<td>Mechanical Engineering Technology</td>
<td>0</td>
<td>50</td>
</tr>
<tr>
<td>Electrical Engineering Technology</td>
<td>3</td>
<td>112</td>
</tr>
<tr>
<td>Agricultural Mechanization Technology</td>
<td>5</td>
<td>27</td>
</tr>
<tr>
<td>Computer Hardware Technology</td>
<td>1</td>
<td>36</td>
</tr>
<tr>
<td>Architectural Drafting</td>
<td>3</td>
<td>31</td>
</tr>
<tr>
<td>Building Construction Technology</td>
<td>0</td>
<td>78</td>
</tr>
<tr>
<td>Wood Construction Technology</td>
<td>0</td>
<td>33</td>
</tr>
<tr>
<td>Plumbing And Gas Fitting Technology</td>
<td>0</td>
<td>39</td>
</tr>
<tr>
<td>Furniture Design and Construction Upholstery</td>
<td>0</td>
<td>33</td>
</tr>
</tbody>
</table>

Source: Author
<table>
<thead>
<tr>
<th>STEM-related TVET Courses</th>
<th>Female Enrolment</th>
<th>Male Enrolment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor Vehicle Engineering</td>
<td>8</td>
<td>101</td>
</tr>
<tr>
<td>Welding and Fabrication Technology</td>
<td>10</td>
<td>56</td>
</tr>
<tr>
<td>Mechanical Engineering Technology</td>
<td>16</td>
<td>74</td>
</tr>
<tr>
<td>Electrical Engineering Technology</td>
<td>30</td>
<td>173</td>
</tr>
<tr>
<td>Agricultural Mechanization Technology</td>
<td>12</td>
<td>25</td>
</tr>
<tr>
<td>Computer Hardware Technology</td>
<td>17</td>
<td>49</td>
</tr>
<tr>
<td>Architectural Drafting</td>
<td>15</td>
<td>38</td>
</tr>
<tr>
<td>Building Construction Technology</td>
<td>14</td>
<td>102</td>
</tr>
<tr>
<td>Wood Construction Technology</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td>Plumbing and Gas Fitting Technology</td>
<td>11</td>
<td>59</td>
</tr>
<tr>
<td>Furniture Design and Construction Upholstery</td>
<td>10</td>
<td>15</td>
</tr>
</tbody>
</table>

Source: Author
<table>
<thead>
<tr>
<th>Participant</th>
<th>Age</th>
<th>Region</th>
<th>Course</th>
<th>Background</th>
<th>BECE Results</th>
<th>School Year</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>F:</strong> Father</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>M:</strong> Mother</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>17</td>
<td>Western</td>
<td>Welding and Fabrication Technology</td>
<td>Parental Education</td>
<td>F: SSS</td>
<td>28</td>
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Source: Author
Enyan Abaasa Technical Institute Records

Table 4.5: Third-Year STEM-Related TVET Enrolment According to Gender

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Source: Author
Table 4.7: Third-Year STEM-Related TVET Enrolment According to Gender

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<td>F: None</td>
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<td>Farmer</td>
<td>None</td>
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</tbody>
</table>

Source: Author
4.4.3 Sampling Education Policy Documents

The sampling of education policy documents involved identifying education policy documents such as TVET reports and education strategic plans for the CDA component of the research. The four broad inclusion and exclusion criteria used in the documented sampling process were as follows:

1. The documents must be specific to Ghana.
2. The document must focus on TVET practice and policy.
3. The documents must be publicly available online or at the education department.
4. The document must be recent, dating from within the last 12 years (2010–2022).

The following core reasons guided the inclusion and exclusion criteria. First, the context of the research is Ghana. The year limit was essential to identify potential trends without going back in time to collect documents irrelevant to current happenings within the TVET sector. One main reason for this is that the TVET sector in Ghana has experienced continual rapid growth over the last ten years and is receiving more policy attention than ever before. Six primary documents met the criteria and were selected for the CDA. These were as follows:


4.5 Generating Data with Young Women: Life History Interviewing Approach

A data-generation approach, which elicited information about the participants’ past and ongoing lived experiences, was used to answer RQs 1 to 4. A life history interviewing approach seemed the most appropriate for this purpose. As a data-generation method, the life history interview approach enabled the elicitation of information about particular past experiences and about how those experiences translated into current lived experiences (Jessee, 2018). Also, using a life history interview approach enabled the young women to reflect on their educational choices and ongoing experiences as STEM-TVET learners (Bornat & Bytheway, 2012; Byrne, 2017). The opportunity for young women to reflect on their lived experiences empowered them as co-research participants whose life stories and
voices generated knowledge for transformative change. Thus, young women were constructed as experiential experts using a life history interviewing approach within IPA (Smith et al., 2009). Life history interview questions using a semi-structured approach (as shown in Appendix M) facilitated conversations in a natural process. The process elicited in-depth narratives and invited the young women to be analytical about their self-reports and how they interpreted their lived experiences (Smith et al., 2009; Winiarska, 2017).

Although the life history interviewing approach was appropriate for the research, as previously noted, it resulted in unverifiable self-reported narratives susceptible to interviewee subjective biases (Creswell, 2014). One primary concern with self-reporting is the provision of incomplete accounts; this is to be expected because human memory is not a videotape recorder. Other scholars are pessimistic about self-reporting techniques, especially in decision-making research, because decision-makers frequently overestimate minor attributes compared to quantitative models. Despite these challenges, Harte and Koele (1995) and Nisbett and Wilson (1977) are convinced of the advantages of self-report techniques. For instance, Harte and Koele (1995) experimented using structural modelling, process tracing and self-report techniques and found that all three techniques are equally helpful for studying decision-making. Nisbett and Wilson (1977) further argue that subjective reports about decision-making are correct, less false, and superior for research that explores experiences in which memories are important. However, Nisbett and Wilson (1977) caution that restricted access to content could mislead reporters when non-influential factors become more vivid and available to the individual. The caution created a sense of cautiousness throughout the interviewing and analysis process to dig deep into the narratives and not use surface values. For instance, when young women expressed a general sense of change, they were asked to narrate an actual example of such an occasion. A typical example was my session with Ajo, an enthusiastic third-year electrical engineering student:

Researcher: What will you say has changed throughout the programme?
Evi: Yes, there have been changes throughout the programme.
Researcher: What in particular can you identify has changed?
Evi: Yes, the syllabus has changed. I think the principles and installation aspect. Principles used to be more complex than the installation, but now, [laughs] there are thousands of calculations [laughs]. So now, principles are more accessible for us to understand than installation.

As illustrated and explained above, there was a conscious effort to ensure the credibility of the self-report techniques used throughout the research, as these young women reflected on,
interpreted, and indicated valuable memories that were meaningful to their decision to study STEM-related TVET courses.

**4.5.1 Instrumentation for Life History Interviews**

Like other IPA and life history research, the semi-structured interview guide in Appendix M was developed to guide the life history interviewing process (Cassidy et al., 2011; Eatough & Smith, 2017; Smith et al., 1999, 2009; Smith, 2011; Smith & Osborn, 2008). The interview schedule consisted of sub-questions that explored the five research questions (see Creswell, 2014; Gallagher & Francesconi, 2012; Tharenou et al., 2007; Webb & Welsh, 2019; Wojnar & Swanson, 2007). Insight from the theoretical framework and other existing qualitative research in this tradition guided the framing of the semi-structured questions. A similar approach was adopted by Masson et al. (2016). In addition to the sub-questions, the interview schedule had a set of probes and prompts that aided the questioning. These question probes, as illustrated in Appendix M, were simple phrases that guided the interviewees to give clarification and further explanations.

On the other hand, the question prompts were phrases that facilitated in-depth interview exchanges without emotionally or physically stressing the young women (Goldman et al., 2003). For instance, I frequently asked, “Was it a personal decision?” to ascertain whether young women considered their decision to study STEM-related TVET courses with any form of imposed influence. An example is shown in the interview with TY8-CCTI. After she explained how she decided to study STEM-related TVET courses, it was noticeable that there had been a substantial external influence: I wanted to understand how these influences had affected her decision. Hence, I asked her whether or not she considered her decision to be a personal choice:

**Researcher:** So, is your decision based on your circumstances?

**Amo:** Yes.

**Researcher:** Do you think doing engineering allows you to support your mum, and how?

**Amo:** Yes. Okay, there is a company in our village. It is a mining company. I have studied the company very closely, and they have no girls. It sounds like maybe if, after completion… later on, I became okay with it.

**Researcher:** Was this a personal decision without any external influence?

**Amo:** Yes, it was a personal decision.

Unlike typical life history interviews, which unfold in a series of face-to-face interviews, the current life history interviews were single face-to-face interviews. The
primary reasons for this were limited time and limited financial resources. These interviews lasted about one hour on average, with four cases exceeding one hour. Though these were lengthier interviews than expected, they made up for not conducting a series of interviews. The length of the interviews also showed how the young women were open-minded and enthused to talk about their lived experiences. It is important to note that there was no research pilot before the fieldwork in Ghana because of the school closures and the travel restrictions caused by the COVID-19 pandemic.

Finally, the interviews were conducted on weekdays. Conducting interviews on weekdays was a change from the initial proposal, which suggested conducting interviews during weekends to ensure minimal disruption of academic activities. The change was necessary because the school principals preferred weekdays in order to provide a level of supervision during the interview sessions. Their responsibility to oversee the interviews was in line with their ethical duty, as being in loco parentis to protect these young people. I accepted this new agreement because it gave me enough time to conduct interviews five days a week instead of two days over the weekend. Despite the interviews happening on weekdays, the ethical aim to prevent the research from disrupting lessons was still attainable because interviews took place after lessons. Lastly, the interviews were conducted in English, Ghanaian schools’ primary medium of instruction. However, two of the young women expressed themselves in Twi (the most common Ghanaian language), which I understand. All interviews were audio-recorded with additional field notes to facilitate transcription.

4.5.3 Interviewing Young Women

The interviews with young women began with a systematic structure to receive informed consent, build trust, and develop rapport. The first step of this systematic structure was to organise an information session with the sampled young women in each school. The information session was an additional gateway for young women to understand the research better and acquire the necessary information, such as the research processes and the research benefits, which enabled them to give informed consent. The young women asked questions, such as the length of the interviewing process and answers to these questions helped reduce misinformation about the research. A primary emphasis of the information sessions was to inform these young women about the relevance of the research and how, through their participation, they could use their voices to inspire change in the TVET policies concerning young women’s participation in STEM-TVET in Ghana. These conversations also played a role in the gradual process of building rapport and trust (Baxter & Jack, 2008; Blaxter et al., 2006; Creswell, 2014).
The individual face-to-face interviews began in February 2021. A typical interview began in the afternoon or late afternoon on the premises of each school. The interviews were either in an empty classroom with open ventilation or under trees with good shade. After each interviewee had settled in, she was asked about her general well-being and to provide additional verbal consent before the interview began. After verbal consent was received, the research was reintroduced as a final check of her understanding. By the end of these procedures, the young woman was ready for her interview in a calm and relaxed atmosphere with limited access to other learners, teachers, or school authorities. Throughout all the interviews, the young women were assured of confidentiality and anonymity. The interviews began with the ‘star question’: ‘Can you kindly talk about yourself?’ The concept of a ‘star question’ is similar to icebreakers. However, it also put the young women in the spotlight and made them feel comfortable knowing the research was about them in totality. I introduced a second-star question as a reflexive part of the research process: ‘Tell me about your background, home, or family.’ This second-star question was necessary because three young women could not articulate their answer to the first-star question but easily engaged confidently with the second-star question.

There was a conscious effort to build trust and allow the young women to lead the conversations throughout the interviews. For instance, in cases where young women could not continue the interview, they took breaks to relax, especially when they revealed sensitive information like the death of a parent. When it was noticeable that the young women might not have understood a question, it was rephrased for clarity. When there was the need for more clarity, probes and prompts like ‘Can you explain further?’ ‘What did that mean to you?’ ‘Can you be clear?’ and ‘Can you please go into details?’ followed the answers. Also, there was good eye contact with the young women with minimal activities to disrupt the process. For instance, bullet points of ideas were used instead of writing extensive notes during the interview sessions. Throughout the entire conversation, there were continuous reminders about how the young women had the right to end the discussions at any time. These were conscious processes adopted to ensure trust and rapport during the interviews. The concluding question ensured that all research areas were exhausted and that the young women were satisfied with the conversation. The young women expressed their satisfaction with the interviews.

4.7 IPA Analysis of Young Women’s Narratives

Data generated from the rich, in-depth narratives of the lived experiences of young women comprised 26 audio recordings, of which 23 were interviews in English and three in
Twi. The IPA employed was the dual interpretation process proposed by Smith et al. (2009). The dual interpretation process involved ideographic and hermeneutic approaches (Smith et al., 2009). The analysis began with the ideographic approach, which involved individual analysis of the 26 young women’s narratives. The next step was the hermeneutic process, which involved extracting meanings and interpretations (Smith & Osborn, 2008).

Six main steps recommended by Smith and Osborn (2008) were employed: reading transcripts, initial noting, developing emergent themes, connecting themes, constructing superordinate themes, and writing up findings. Although Smith and Osborn (2008, p. 76) do not precisely identify the analytical process as thematic analysis, they acknowledge that “processes in IPA were similar to thematic analysis.” Therefore some thematic analysis strategies are drawn from the works of Braun and Clarke (2006). In addition to employing these six significant steps, other specific strategies like tables, annotations and identifiers facilitated the analytical process (Smith et al., 2009).

Although Smith and Osborn (2008) propose reading the transcript as the first step in the analysis process, it was necessary to organise the data generated to identify sets for transcription and store them on a password-protected laptop. The Sonocent Audio Notetaker software (a note-taking system that recognises the audio recorder systems, extracts recordings, and enables transcription) aided the organisation process. Therefore, the first process was to transfer the audio recordings onto the Sonocent Audio Notetaker on a password-protected laptop. After successfully extracting each recording, each was labelled with a code consisting of letters and numbers. The coding system was a combination of the young woman’s school year, the initials of the technical school she attended and her number as an interviewee within the school. A typical label would be Esi, which is interpreted as a first-year learner, designated number 4, at Enyan Abaasa Technical Institute. The labelling process enabled the anonymisation of the recordings before transcription. It also made identifying files easy and increased the credibility and confidentiality of the anonymisation process (Creswell, 2014).

Subsequently, the 26 audio recordings of the young women using the Sonocent Audio Notetaker software’s speech-to-text function were transcribed. I also used the Dragon software package that functioned with the Sonocent Audio Notetaker to convert audio recordings to text. I began the process by listening to the tape recordings, familiarising myself with each young woman’s narrative content and making notes. After the initial listening and familiarisation process, I began the speech-to-text process to generate verbatim text of the narrative of each young woman. This process produced over 1,000 pages of transcripts.
The next step was cross-verifying the initial transcripts by listening to each audio recording for a second time. The cross-verification process helped correct all errors in the initial transcript and helped capture nuances in the form of notes and comments. The notes and comments focused on thoughtful and emotional expressions, such as reflective pauses during the interviews. Since young women were the experiential experts and the entire data-generation process was a reflexive process, transcriptions were done the same day of the interview or, at the latest, by the day after each interview, which enabled me to ask additional questions when necessary. It also helped me to make necessary amendments and adjustments as the fieldwork progressed. For instance, after following up with the first few interviewees, I identified the need for a second-star question when I noticed from the transcript that the first-star question was not necessarily eliciting the most appropriate responses. I tried the second-star question, and according to those initial interviewees, the second-star question was helpful; hence, I alternated the start questions as and when it was most helpful.

Finally, the data was ready for reading, as Smith and Osborn (2008) propose. The transcripts were a semantic record consisting of a verbatim write-up of each interview session; the write-up included the questions to the young woman and their answers, with nuances captured in brackets (Smith et al., 2009). After the initial reading, a second reading of the transcripts helped me familiarise myself further with the young women’s narratives and prepared my mind for rigorous analysis (Braun & Clarke, 2006; Creswell, 2014).

After the extensive readings and further familiarisation with the transcripts, the initial note-taking process began as the second stage of the IPA. The first step was the case-by-case ideographic analysis which involved using the reference, text, and audio tools of the Sonocent software to organise each transcript into meaningful data. For example, each transcript was categorised into about six different units per every ten minutes of audio. The process also included a level of first-order interpretation of the meanings of the narratives. In these interpretive instances, explorative notes explained elements of the lived experiences of the young women. The note-taking process guided the generation of a thorough and detailed set of notes and personal reflections on the data. Smith et al. (2009) argue that this initial note-taking process is relevant to complement prior reading for further detailed analysis. These rich descriptive, conceptual, and explorative notes captured explicit meanings of young women’s experiences. The notes captured the individual transcripts’ similarities, differences, conditions, and amplifiers. As Smith et al. (2009) point out, the initial note-taking involved a process similar to the notion of appearing developed by Heidegger. The notion of appearing presupposes that the phenomenon’s implications occur in the text, and a detective approach
would bring it outside for further interpretation and meaning-making (Smith et al., 2009). In this sense, the notes in a holistic lens had themes of meanings about young women’s lived experiences, which began to appear from the transcripts after this scrutiny.

The next step was the development of emergent themes. In this process, both inductive and deductive approaches were used. First, a manual coding process guided the generation of the emergent themes across all the transcripts. The manual process involved systematically highlighting richer and illuminating data bits with specific colour codes and subsequently associating data bits with emerging themes. The five colours used for the manual coding were red, green, pink, blue and yellow. The analysis at this point employed an inductive approach with first-order analysis, which involved a bottom-up method free from pre-existing codes, theoretical frameworks and analytical preconceptions (Braun & Clarke, 2006; Smith et al., 2009). Although the inductive coding approach was free from pre-existing codes, theories, and preconceptions, it was impracticable to avoid connecting these themes with notions and concepts emerging from the existing literature and the theoretical framework. It was explicitly true that data collected with semi-structured questions that evolved from the literature review and theoretical framework had themes related to “specific questions” (Braun & Clarke, 2006). Hence, data bits comprising phrases and sentences are sometimes related to concepts and notions that framed the research. The inductive analysis process revealed 19 emergent themes:

1. Influences
2. Yes, I can do it
3. I have the talent
4. Negative perceptions
5. Positive perceptions
6. I am learning hard
7. It is difficult
8. I feel good and proud
9. Choosing STEM-TVET
10. Challenging stereotypes
11. School selection process
12. Identifying responsibility
13. Identifying courage
14. Identifying abilities
15. Matching school, course, interests, and aspiration
16. Support and encouragement
17. Identifying interests and abilities
18. Help-seeking behaviour
19. Learning and practice

The deductive process was the second-order level analysis. One crucial aspect of turning the initial notes into emergent themes was developing clear statements about the transcripts’ essential aspects that answered the research questions. It also involved the *hermeneutic circle* (Smith et al., 2009). This reiterative process captured the essence of data bits either in abstraction or in alignment with the theoretical framework through transcripts. As Smith et al. (2009) argue, emergent themes reflected young women’s original meanings, ideas, and theoretical interpretations. After the deductive process, there were ten main emergent themes:

1. Stereotypes of influence
2. Policy of influence
3. Actions/places of influence
4. Knowledge/perceptions of Influence
5. Influential persons
6. Agency
7. Decision-making
8. Confidence/self-belief
9. Experience/judgement (positive or negative)
10. Comparisons

Employing an inductive form of thematic analysis had advantages for the research. First, Braun and Clarke (2006) posit that combining deductive and inductive approaches gives flexibility, a critical benefit that allows various analytical options to describe and interpret data (Braun & Clarke, 2006). The deductive approach to the analysis was a powerful method to situate the research in the theoretical framework, strengthening the interpretative power of the analysis (Braun & Clarke, 2006). As such, van Manen (1990) argues that it is impossible to bracket out previous ideas and beliefs about a phenomenon of interest; these presuppositions eventually pervade our reflections. Smith et al. (2009) further add that engaging the notions and concepts that framed that research moved the analysis to a second-order stage. Combining inductive and deductive approaches emphasises the argument that coding data in an epistemological vacuum is arguably impossible (Braun & Clarke, 2006; Smith et al., 2009). Therefore, I acknowledged these preconceived ideas and notions, held
them at bay intentionally, and eventually used this knowledge to expose concealed interpretations (van Manen, 1990). Thus, combining inductive and deductive coding was a hybrid process incorporating data-driven and theory-driven approaches to ensure a high level of rigour and clarity while ensuring the process was reflexive and iterative (Fereday & Muir-Cochrane, 2006).

The fourth step in the analytical process was identifying the superordinate themes. Two different approaches were employed to identify a superordinate theme. First was an abstraction process, which involved identifying patterns between emergent themes to form clusters that formed higher-level themes (Smith et al., 2009). The clusters consisted of collated like-with-like themes from the different transcripts. The abstraction process yielded four superordinate themes:

1. Planning a STEM-related TVET journey
2. The dual experiences of young women in STEM-related TVET
3. Developing individual agency
4. Expected progression routes

The second process was subsumption, where an emergent theme obtains a superordinate status. The emergent themes that obtained superordinate status were prominent themes with clear theoretical foundations. The process of subsumption led to the identification of a final superordinate theme: developing individual identities. Thus, after the abstraction process, it was evident that personal agency had a theoretical foundation and could define other clusters of emergent themes, including confronting stereotypes, help-seeking behaviour, aspiration, and learning and practice. The theme was the only emergent theme that evolved into a superordinate theme through subsumption. As the theme emerged, it became apparent that all the young women, even the first years, were agents mediating structures, culture and stereotypes concerning the participation of young women in STEM-related TVET courses. It was one of the emergent themes, and it brought together a series of related emergent themes common among all the narratives.

Other processes employed for the general identification of superordinate themes were contextualisation and numeration (Smith et al., 2009). Contextualisation was used to understand the unique contexts of young women. Contextual factors like rurality and low-income background were relevant to the analysis. Numeration was used to generate the superordinate themes. The numeration process used in the research involved counting the superordinate theme across the 26 cases using a simple yes or no strategy (see Appendix B). The rule was that for a theme to emerge as superordinate, it should be recurrent in all 26
narratives. It simply meant the superordinate themes were recorded across all 26 transcripts. Smith et al. (2009) argue that counting the recurrence of themes to assess prevalence further enhances the validity of findings.

After identifying superordinate themes, the last process was to write up the findings. This was the critical process of bringing everything together in IPA (Smith et al., 2009). The five final superordinate themes were:

1. Planning a STEM-related TVET journey
2. The dual experiences of young women in STEM-related TVET
3. Developing individual agency
4. Developing individual identities
5. Expected progression routes

Although there is no normative way to write up findings for IPA research, specific relevant characteristics of the write-up process were adopted from Smith et al. (2009). The first process was to present each superordinate theme and then explain it through the lens of young women and beyond. The second process was to present supporting themes when available and then use quotes from the young women to support the theme. It was an efficient approach to presenting the theme’s subjective interpretations and evidence. An intentional effort was to select evidential quotes to provide readers with provocative and exceptionally enlightening extracts. These extracts also portrayed the validity of the superordinate themes. The third process was a comprehensive, systematic, and persuasive write-up of this thesis, which helps the reader share the lifeworld of young women studying STEM-related TVET courses in upper secondary technical schools in Central and Northern Ghana.

4.8 Critical Discourse Analysis (CDA): Practical Argumentation Structure

The CDA applied in this research focused on the discourses adopted in education policy. The overall process of the CDA in this thesis generally followed the General Analytical Framework for CDA (Mullet, 2018), as shown in Table 4.11.

Table 4.11: General Analytical Framework for CDA Stage

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Objective</th>
<th>Evidence of Rigour</th>
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<tbody>
<tr>
<td>Reflexivity (Morrow, 2005)</td>
<td>Transparent view of whose reality is represented in the research</td>
<td>Self-reflective journal, peer debriefing, asking for clarification, member checking, focus groups.</td>
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<tr>
<td>Subjectivity (Morrow, 2005)</td>
<td>Transparent view of researcher bias</td>
<td>The researcher articulates their positionality, monitoring of self, and rigorous subjectivity.</td>
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<tr>
<td>Adequacy of data (Lincoln &amp; Guba, 1985)</td>
<td>Adequate evidence (completeness) Adequate sample Adequate variety of data</td>
<td>Data gathered to the point of redundancy; new data reveal no new findings. Purposeful sampling strategy. Use of multiple data sources. Clearly articulated analytical framework.</td>
</tr>
<tr>
<td>Adequacy of interpretation (Morrow, 2005)</td>
<td>Analytical framework Immersion in the data Disconfirming Disconfirming evidence</td>
<td>Repeated forays into the data (e.g., repeated readings of transcripts). Deliberate search for potentially disconfirming instances. Comparisons of disconfirming with confirming instances.</td>
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<tr>
<td>Deviant Deviant case (Miles &amp; Huberman, 1994)</td>
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<tr>
<td>Authenticity (Guba &amp; Lincoln, 1994; Seale, 1999)</td>
<td>Educatve authenticity Catalytic authenticity Fairness Social</td>
<td>Participants’ understandings of others’ constructions expand. Action or change that redistributes power from the dominant to the disempowered. Different constructions are represented.</td>
</tr>
<tr>
<td>Consequential validity (Patton, 2002)</td>
<td>Social or political change</td>
<td>Increased consciousness: perspectives of those who</td>
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are silenced or disempowered are amplified.

Accessibility (Wodak & Meyer, 2009)

Audience for the research includes the participants

Findings are readable and comprehensible by the social groups under investigation.

Theoretical triangulation (Wodak & Meyer, 2009)

Four levels of context: Immediate language; Interdiscursive relations; Immediate social context; Broad social context

All four levels of context are represented and discussed in the analytical framework and the analysis.

Source: Mullet (2018, p. 122)

The General Analytical Framework was framed with four practical argumentation perspectives: the circumstantial premise, the value premise and the goal premise, and the means-goal premise. The circumstantial premise concerns the representations and problematisation of the under-participation of young women in STEM-related courses in technical schools. The value premise concerns the underlying values that inform the motivation to raise the concerns expressed in the circumstantial premise and the motives that drive the proposed means-goals to change the circumstantial premise. The goal premise refers to how education policy discussed measures to achieve desirable outcomes. These desirable achievements correlated to the values expressed in education policy discourses. The means-goal premise concerned a conditional assumption that if education policy took specific prescribed actions, these actions would become the means to increase the participation of young women in STEM-related TVET courses, which was the desired goal (Fairclough, 2013)

The first part of the CDA involved scrutiny of discourses in the six policy documents and involved seven primary processes. The first and second processes involved identifying and reading policy documents that concerned TVET. The process included additional reading to identify and explore the background of the documents. The next step was to use the different practical argumentation commitments presented in the policy documents to identify overarching themes; a colour coding scheme was used to highlight specific text extracts that contained premises of interest. The circumstantial premises were identified with red, value premises with green, goal premises with yellow and mean-goal premises with blue. There
was a need to structure the text to enable proper scrutiny and to copy and paste the selected text into a tabular format classified under the four main premises. After the tabular presentation of the initial text, the next step was to critique the discourse concerning the problem–solution approach adopted in the policy document in connection with the realities of the problem and how the discourses may or may not address the problem adequately (Mullet, 2018). The final stage was to discuss and interpret the discourse used in these policy documents and the narratives from the young women, the policy officials, and the existing literature.

The circumstantial premises were identified with red, the value premise with green, the goal premise with yellow and the mean-goal premise with blue. After the colour coding and additional re-reading, the next step was to discuss the policy context. Figure 4.4 shows a methodological map of the entire processes and approaches adopted to produce the qualitative data.

**Figure 4.4: Research Methodology Map**

Source: Author
4.9 Ethical Considerations

Informed consent, confidentiality, gaining access and debriefing were the primary ethical principles guiding the overall conduct of this research (British Educational Research Association/BERA, 2018; Cohen et al., 2017; Creswell, 2014). The research conformed to the policy on the Ethics of Research Involving Human Participants and Personal Data of the University of Cambridge. Hence, the research needed ethical approval from the University of Cambridge Research Board and other context-specific organisations, such as the GES, to proceed according to agreed ethical principles. Additionally, the research conformed to other research conduct checklists like the BERA Ethical Guidelines for Educational Research (fourth edition, 2018) and Bell's (1991) checklist for undertaking school-based research. The aim was to ensure ethical rigour through adherence to all necessary ethical principles and guidelines. It is important to note that the final decision to participate in this research rested with the identified young women. Based on previous experience in Ghana, a practical approach to gaining independent, informed consent from young people emphasised that their decision to participate or not participate in the research would not affect their academic work and relationships with principals. Another way to achieve independent consent was to explain how the consent of the young women as co-informants is significant to the research's validity, accountability, and credibility. Most importantly, giving informed consent was an agreement to use data for subsequent publications (see Appendix G).

4.9.1 Respect for Co-Participants

The primary ethical principle of relevance to the conduct of the current research is respect: respecting young women and their narratives and the knowledge they reveal is vital. Respecting the young women in this research was also a process of valuing their freedom. Hence, young women chose to be co-participants in the study without compulsion and had the option to withdraw their narrative up to one month after fieldwork (Smith et al., 2009). Related to respect was informed consent, which is the key to achieving autonomy and freedom in the study. Gaining informed consent, as discussed earlier, was a hierarchical process, from the macro-level (national and regional level GES directors) to the meso-level (district GES directors) and the micro-level (principals and young women). The young women received information about the risks and benefits of the research so they could make an informed decision.

4.9.2 Competence to Make Decisions

Another ethical principle of relevance to the current research is competence, arising from whether the participants have the right level of responsibility and maturity to assess the
risks and benefits of participating in the research. Competence to make decisions was critical because most young women were highly likely to be below 18 years of age and were considered children according to the Child Rights Act (Cohen et al., 2007; Ministry of Education, 2018a). Therefore, the aim to seek informed consent from other adults and principals was to enable them to analyse the benefits and risks of the research provided and explain these, with perceived responsibility for the safety of the child and with a sort of maturity that children may not possess (Cohen et al., 2017). As discussed earlier, being in \textit{loco parentis}, principals act in place of parents since the young women of interest are highly likely to be in boarding school and, therefore, in the care of their principals during the fieldwork. The information packs distributed for consent contained detailed, comprehensive and straightforward explanations for the different participants (Cohen et al., 2007). Appendices E, G, H, I, and J are samples of the access letter, permission letters and informed consent forms.

4.9.3 Data Protection

The Data Protection Act (1988) guided data storage in the current research and its next act, the General Data Protection Regulation 2018 (GDPR). Participants had complete information about their relevant data storage, processing, and usage. A password-protected computer held all data without access by others: all folders and files related to the research data and data analysis used pseudo names which differ from the true names of the participants. In asking for the consent of young women for data protection, protecting the privacy of young women through anonymising collected data, avoiding any form of data breaches, and ensuring safe handling of the transfer of data between Ghana and the United Kingdom, the research upheld core components of the GDPR 2018.

4.9.4 Privacy and Protection

Ensuring young women’s privacy and protecting young women from physical and emotional harm was an ongoing process in this research. The privacy and protection process focused on the sensitivity of the information asked for and the collecting and safeguarding of personal details and publication findings (Cohen et al., 2007, 2017). To achieve privacy, the principle of confidentiality guided the collection and storage of data and the publication of personal information and findings (Alderson & Morrow, 2004). As Alderson and Morrow (2004) recommend, I ensured that the selected young women understood and agreed not to use their real names. Using pseudo names did not take away the acknowledgement of their relevance as co-researchers. Although confidentiality is essential, total confidentiality may not be achievable when dealing with children and young people due to child protection.
concerns (Alderson & Morrow, 2004). Therefore, if safeguarding issues like self-harm or abuse arose, I intended to inform the young women of the necessity to share information with the proper authorities, like a principal. Another privacy measure was that other individuals outside the research, like the principals and teachers, were present during the interview sessions. For confidentiality reasons, no unauthorised person can access the narratives of the young women during or after the recording. When disclosing information from the narratives was necessary, there was no trace of participants’ identities.
Chapter 5. IPA Findings and Discussion

The current chapter aims to understand young women’s experiences as STEM-related TVET learners in upper secondary TVET education in Ghana by presenting the IPA analysis of young women’s co-constructed narratives. The young women interviewed studied various courses outlined earlier in Tables 3.4, 3.6, 3.9, and 3.10. Despite this heterogeneity in courses, the analysis highlighted many shared experiences across the spectrum of participants. Furthermore, the narratives extended beyond young women’s experiences of being STEM-related TVET learners to yield a diverse range of topics, such as progression pathways considered by these young women.

All quotations come directly from the verbatim transcriptions with minor sentence construction and grammar changes. From each of these quotations, the young women’s voices become visible. In addition, excerpts were selected if they embodied the themes and demonstrated either convergence or divergence of experiences. There was an intentional selection of quotations that reflected the experiences of participants. Quotations were necessary to increase the clarity and relatability of the findings. The five superordinate themes that appeared from the IPA analysis were: (1) planning a STEM-related TVET journey; (2) dual experiences of young women in STEM-related courses; (3) developing individual agency; (4) developing individual identities; and (5) expected progression routes.

5.1 Theme 1: Planning a STEM-Related TVET Journey

Planning a STEM-related TVET journey emerged as a core aspect of the experiences of being a young woman taking STEM-related TVET courses. Apart from three unique cases, for all young women in the current research, choosing STEM-related TVET courses began with planning and navigation at JHS. While there were uncertainties and challenges, these young women used the planning period to investigate their aspirations, generate preliminary validation, and seek support for their STEM-related TVET educational choice. This overarching theme consisted of six sub-themes: (1) identifying a concrete occupational goal; (2) exploring subject interests and abilities; (3) addressing validations and invalidations; (4) dealing with reinforcers and underminers; (5) navigating school and course selection; and (6) having retrospective affirmations. Participants reported their STEM-TVET aspirations by the first year of junior high school (JHS). Throughout JHS, they reported exploring their interests and abilities in STEM-related subjects, which were seen as valuable to their STEM-TVET aspirations. Finally, these young women narrated how they navigated the school and course selection process in the third year of JHS.
5.1.1 Concrete Occupational Goal

Participants reported a superior certainty about their long-term career goals at the beginning of JHS. The participants narrated that by the first year of JHS, they had developed certainty and formed a sense of confidence in their choice to study STEM-related TVET courses to become engineers. Aba, in her final year of a mechanical engineering course, reported:

I had to make up my mind to continue my education and have a career as an engineer. Although it is difficult, I am brave and confident in my decision to study STEM-related TVET courses that would benefit me in the future.

(Aba)

Efa said:

By JHS 1, I was about 11 years old and wanted to be a road constructor. I decided to choose technical schools to become a building construction engineer. I was sure I would choose a technical school for my placement.

(Efa)

However, the participants appeared to be divided into two groups based on the direction of their occupational goals. The first group appeared to gravitate towards direct STEM-related TVET occupational goals. These participants reported having the intention to use their STEM-related TVET skills directly in careers such as mechanical engineering, electrical engineering, computer software engineering and computer hardware engineering. For instance, Ajo stated:

When I got to the JHS level, I told myself that I wanted to become an electrical engineer in the future, and so I said that I had to learn well because I knew I could do it. (Ajo)

The other group were participants who appeared to gravitate toward indirect STEM-related TVET occupational goals. This second group of participants reported the intention to indirectly apply their STEM-related skills and knowledge in careers that were not pure engineering, such as the armed forces. For example, Ago narrated:

I plan to use my certificate to apply to the military. I believe I will be able to use the skills and knowledge I have acquired in a military job. (Ago)

Furthermore, participants reported that consciousness of their STEM occupational goals developed without formal career guidance and counselling. The narratives of these young women appeared to suggest that regardless of access to formal career guidance and
counselling opportunities, young girls aged 11 and 12 in Ghana may have consciously developed a sense of career orientation that they aspire to achieve. In Ado’s words:

I am trying to say that I had not known more details about this programme before choosing it. I made this decision based without sufficient knowledge and understanding of technical education. There was no guidance and counselling in school I could access. I love the course, but I wish I had more knowledge and understanding about it before I started. (Ado)

Ata said:

No, I did not receive any guidance on our schools, courses in electrical engineering and jobs in it. For example, we were given the school placement pamphlet in class for selecting schools. We were four girls and three boys in class, but the book was only one. It was placed in front of us so that we should search for our schools. (Ata)

As discussed by the participants, the concept of concrete occupational goal appeared to convey a similar interpretation to similar concepts that have been widely studied in the existing literature. These include the notion of a personal project, discussed by Archer (2014) and the concept of aspirations and capabilities as seen in Kang, Keinonen, et al. (2019), Levey et al. (2018) and Unterhalter (2017). The participants’ discussions about concrete occupational goals provided an understanding of when young women in Ghana might intentionally consider their occupational goals (Conradie & Robeyns, 2013; Hart, 2016; Robeyns, 2003, 2005b, 2006). Thus, the overarching explanation could be that these young women had well-defined ideas about their future lives and how making a concrete decision by JHS 1 was relevant to that process.

Further, the findings on the long-term occupational goals of these participants were consistent with studies on children’s future goal orientation, which have shown that the idea of thinking and planning towards distant future goals becomes prominent between the ages of 11 and 12 (Nurmi, 2005). As Nurmi says:

At the age of 11, more future-oriented topics, such as studies, career, marriage, leaving the parental home, and the future of society, emerge in children’s thinking. Adolescents and young adults report future education, occupation, family, and leisure activities. In middle adulthood, individuals begin to mention more goals related to their children’s lives, property, and leisure activities. (Nurmi, 2005, p. 46)
Reiss and Mujtaba (2016) also explain that subject aspirations and career aspirations are inseparable at ages 11 and 12. This is because learners at this age begin to select their subjects with career choices in mind. Thus, young learners begin to know that their subject choices are significant to future occupational aspirations, and this knowledge reinforces subject choices (DeWitt et al., 2019). Kang, Keinonen, et al. (2019) emphasise that the conscious connection between STEM courses and STEM aspiration is relevant at this stage because most advanced science programmes in higher levels of education require the study of science subjects at the secondary school level.

The findings on these young women’s clear occupational goals at age 11 were consistent with the child’s goal element of the expectancy-value model. According to this model, young people are highly likely to establish their long-term occupational goals early in life and work towards achieving them (Eccles & Wigfield, 2002; Wigfield & Eccles, 2000). One possible interpretation is that these participants at age 11 can be described as capable agents framing their life projects by first identifying their occupational goals. The ability of the participants to decide at this age shows them in a positive light as designers and creators of their aspirations, rather than inactive or deficit citizens whose life projects are determined by social constraints and structural inequalities. Thus, it can be said that these young women had set agentic goals for themselves (Petersen & Hyde, 2014a; Tellhed et al., 2016). The participants were focused on the long-term benefits of their occupational choices, such as gaining employment (Petersen & Hyde, 2014a; Tellhed et al., 2016). For instance, Efa explained:

I wanted the technical programme because I want to be a military woman. However, before I could go to military training unless I had a skill, they would not sign me up if I did not get that skill. So, I decided to join the electrical class. (Efa)

The findings on the absence of formal career guidance and counselling were consistent with Ajayi et al. (2013), which found inadequate access to guidance and counselling services to be a common concern among JHS students in Ghana. The general concern was that inadequate formal career guidance and counselling could disproportionately affect students, especially girls from less privileged backgrounds with little or no social capital to seek guidance. Meanwhile, what can be explained is that, though these young women were not formally guided in their education and career decision, it seems they were accessing other sources of guidance. This is reflected in the validations and support they sought from close relatives, teachers, and community members. The sub-themes of
invalidation and reinforcement and underminers delved into how these young women sought guidance informally.

In Ghana, three possible reasons might explain why young women in this study had already formed concrete long-term STEM-related TVET occupational goals by JHS. Firstly, at the beginning of JHS, learners become conscious of the inevitable need to choose a course and school for upper secondary education. Secondly, learners in JHS begin to learn pre-technical and vocational subjects, which exposed these young women to prospective upper secondary STEM-related TVET courses. Thirdly, because JHS is the only link to upper secondary education in Ghana, it is anticipated that learners at this level consider a career and perform well in subjects related to those occupations (Adu-Gyamfi et al., 2016; Akyeampong, 2002; Gyaase & Adu-Gyamfi, 2012). These three assumptions could provide an additional contextual explanation as to why these participants had developed concrete ideas about their identified education and career aspirations by the first year of JHS.

In terms of future planning, the research suggests that the young women had a superior level of certainty about their career orientation by the beginning of JHS, which led to their participation in STEM-related TVET courses in upper secondary school. One group of these young women's participation in STEM-related TVET courses is directly linked to engineering careers. For another group of these young women, their career orientation was indirectly linked to fields that needed the application of engineering skills, such as the military. This career decision occurred at age 11 for these young women, albeit without career guidance and advice. This, therefore, raises the question of how these young women could generate the knowledge needed to make these choices. The following two sections explore this in detail.

5.1.2 Exploring Subject Interests and Abilities

Participants reported that between JHS 1 and 2, they explored their interests in three STEM-related TVET subjects: pre-technical drawing, maths, and general science. Thus, after confirming their occupational goals by JHS 1, participants appeared to continue planning their STEM-related TVET education by identifying and exploring their interest in STEM-related subjects valuable to their occupational goals. Ago reported:

In JHS 1, I identified my interest in pre-technical drawing. We only started it in JHS, and I enjoyed it right away. I also enjoyed math, and I knew that my interest in these STEM courses was one of the ways to achieve this dream.

(Ago)

Ala said:
One day in JHS 2, our science teacher came to class. He gathered toy components and asked us to build a vehicle, thus a toy car to move. So, he asked us to think critically about it, and I sat down thinking about it… because all the girls in the class were not doing it because they felt they were not into such things. I asked my teacher to send it home to try very well. I sat down and drew the vehicle, thus the little toy car in the book, to see how I would cut out everything to start making the car. My dad came close to helping me do it. After a while, I noticed that my toy car could move.

Around that time, my interest grew in science, and I knew I could study auto engineering. If I could make a car like this in a science class, offering an engineering course would be the best. (Ala)

Atypical narratives show that young women used their level of enjoyment in STEM-related courses such as maths, pre-technical skills, and general science to explore their interest in STEM. Usually, the opportunity to have practical science engagement appeared to be of great relevance to identifying science interests and abilities.

However, there was one situation where a participant associated her interest in science-related subjects with her talent. Ajo was an example of this situation. She believed she was talented in drawing, which meant she could pursue a STEM goal as an engineer. She said:

I decided to join the pre-technical drawing class. I know how to draw, and that was my talent. So, I knew I could study a STEM course. (Ajo)

Further, participants reported that their identified interests or talent in STEM-related subjects were independent of their academic performance in those subjects. For these young women, their academic performance in science, maths and pre-technical drawing did not correlate with their STEM interests. Thus, the narratives of these participants showed that although they had a high degree of interest in general science, maths and pre-technical drawing, there were inconsistent reports of their academic performance in these subjects. For instance, Afi narrated:

I liked science, but I was not good at it that much. As for maths, I was good but not all the time because it is unfortunate that I cannot calculate very well, and I get low grades during exams, but that did not change my interest. I still liked both maths and science. Meanwhile, I liked pre-technical skills because I did well. (Afi)

Evi also stated:
When I was in JHS, I was good at science… and I was good at drawing, so I knew I could study engineering. (Evi)

The finding on participants’ exploration of interests and abilities was consistent with research that has found interest in science and technology–related subjects to mediate girls’ STEM occupational goals (Dierks et al., 2016; Kang, Keinonen, et al., 2019; Lykkegaard & Ulriksen, 2019; Tikly, 2020). For instance, Shirazi (2017) found that a lack of interest in science negatively impacted female students’ science choices and outcomes. The finding contributes to these existing pieces of evidence by showing that apart from general interest in STEM subjects like biology, health sciences and chemistry, young women also have and can develop an interest in technical sciences such as engineering and technology (Blickenstaff, 2005; Karpa et al., 2015; Wang et al., 2013). Other studies have found that girls’ interest in science was a stronger predictor of science education and career aspirations at the middle school stage (Kang, Keinonen, et al., 2019). The evidence shows that even when young women’s performance in STEM subjects was weak, their deepened interest and exposure to STEM-TVET were better indicators for their transition into STEM-related TVET courses than their academic performance. It emphasised the assumption that interest and exposure to science, pre-technical drawing and maths significantly influenced participants to transition to STEM-related TVET courses more than their academic performance. Wang (2013, p. 1107) argues:

The effect of students’ exposure to math and science courses is even more significant than math achievement, which was once deemed the best predictor of students’ future STEM entrance. There is a need to boost high school students’ interest in pursuing STEM fields of study through an earlier introduction and exposure to math- and science-related courses.

Notably, the finding suggested that students’ interest in pursuing STEM can also evoke a long-lasting interest in STEM subjects regardless of academic performance. These findings were consistent with the literature that found that young people make educational and occupational choices based on a solid connection between interest and aspirations. For instance, Kang et al. (2019) found that young women’s interest in science strongly indicates science aspirations. It is most significant when young people develop their future goals early, by the age of 11–13 years. At this age, young people who develop their future goals are more enthusiastic about learning than young people who cannot connect their current interests and values to future goals (Kang, Hense, et al., 2019).
Furthermore, participants’ interest in science was consistent with Eccles’ (2011a) proposed subjective task value. This was the case because participants’ interests in STEM-related TVET courses were subjectively appraised of STEM-related TVET subjects as beneficial interests. Two of these young women seemed to develop a value interest in STEM subjects because they interpreted their interests in science subjects as beneficial for STEM-related TVET education and occupational aspirations. For example, a study of 1448 young people in grades 7 and 9 in Atlantic Canada found that students interested in technical and scientific skills were highly likely to choose STEM courses and careers (Blotnicky et al., 2018). The direct mediator between interest in STEM subjects and STEM careers appeared to be the value these young women associated with accomplishing their occupational goals. McEwen (2013) found that girls who develop these STEM interests and connect them to STEM occupational goals early in lower secondary education were more confident choosing technical careers.

Finally, the finding was inconsistent with one element of the expectancy-value theory model (EVT model), suggesting that young people’s previous achievement-related experiences could directly influence their choice. As the above finding showed, young people may choose a STEM-related TVET course regardless of positive or negative prior academic performance if there is a concrete link between STEM interest and future occupational goals.

In terms of exploring subject interests and abilities, the research has helped us understand that these young women used their enjoyment of maths, science, and pre-technical skills to explore and gauge their interest in STEM-related TVET courses. These young women’s interest in maths, science and pre-technical skills usually arose because they identified these three STEM subjects as relevant to their occupational goals and future aspirations to study STEM-related TVET courses. Their interests in these three STEM-related subjects were not necessarily related to their performance in these subjects. Thus, these young women might have low performance or achievement in STEM subjects but could still have a high degree of interest in them.

### 5.1.3 Validations and Invalidations

Participants reported that during JHS 3, the final year of JHS, they sought confirmation from their parents regarding their STEM-related TVET education and occupational choices. The participants informed their parents of their decision to study STEM-related TVET courses to become engineers through this consultation process. The STEM-related TVET education and career confirmation during JHS 3 were important
because JHS 3 was the critical year where learners chose their upper secondary school pathway, schools, and courses. Aki reported:

In JHS 3, before I wrote the BECE, we had to choose our schools and courses, so I asked my parents if they agreed for me to study a STEM-related TVET course in technical schools. I wanted to know before I made my final decision. (Aki)

Ami said:

I wanted to check if my parents were willing to support my STEM-related TVET education and career aspirations. So, during the school and course selection process, I told them about my decision to know what they thought about the schools and the courses. (Ami)

Further, the participants reported that confirmations were divided into validations and invalidations. The participants reported receiving outright validations for their STEM-related TVET choice from their fathers. Ami said:

I have always been determined to read this program, and once I told my father, he agreed for me to study my chosen STEM-related TVET course. I have the support for my father to become an engineer in Ghana in the future. (Ami)

Ado reported:

He [my father] was the one who encouraged me to choose the course, and we even chose the schools together. I permitted him to help me choose the rest of the technical schools. (Ado)

Fathers who validated participants’ STEM-related TVET choices were usually the main economic actors of the family, as is culturally the norm in Ghana. One possible explanation is that fathers' economic power makes them responsible for educational costs; directly or indirectly, it gives them a higher level of independence to validate their daughters’ non-conformist education and career choices. In the words of Abe:

My father is the one responsible for my education. So, I knew that if he supported my STEM choice, he would pay for the expenses. Although SHS is free, I know I would need money for my care. So, I needed my father’s validation, and when I had my father’s support for my STEM choice, I knew that was all I needed. So, I chose the technical schools, where I could study electronics engineering. (Abe)
In contrast, participants reported that their mothers were divided into ‘typical’ and ‘atypical’ mothers. The typical mothers were categorised as non-economic actors of their families and who predictably did not validate their daughters’ STEM-related TVET choices. Instead, participants reported that these typical mothers suggested that their daughters study courses traditionally associated with females, such as fashion design and catering. Esi explained:

My mum got to know about the course I am reading just recently. She got to know just in Form 2. My mum is not involved in my education. When she got to know, she did not support the idea. She said I should have studied fashion design. (Esi)

Evi explained:

My mum would not have it. She kept asking, can I, do it? Can I, do it? That was what she was always saying. She instead encouraged me to choose catering or fashion because that was for girls. (Evi)

The cases of these mothers were culturally typical, but there were two cases where participants reported that their mothers acted atypically. The two mothers validated their daughters’ STEM-related TVET choices instead of proposing that they study fashion design or catering. The two atypical mothers were reported to be the economic heads of their respective families. It was, therefore, possible to assume that the economic responsibility of these two mothers was the reason they had the authority to make a final decision about validating their daughters’ STEM-related TVET education and career choices. These mothers paid for associated educational costs of STEM-related TVET choices. Ajo, who studied agriculture mechanisation, explained:

Only my mum validated my choice. That was because my dad does not work and could not provide payments for my school cost. So, that made it possible for my mum to support my decision, and it was first my mum who had the economic authority to validate it. (Ajo)

Moreover, it was interesting to note that one of these two mothers acted in a way that has been described as the ‘tiger mother’ in Asian cultures. Thus, this atypical mother, essentially the economic head of her family, validated her daughter’s decision to study electrical engineering. The main reason for her validation was that she rationalised that her daughter’s opportunity to study STEM-related TVET courses could maximise her employment and economic outcomes. For example, Fen reported how her mother decided
that she study a STEM-related TVET course because she wanted her to get a better chance to join the military. She said:

I told our mom that I wanted home economics, and she said no, and I said okay. If she says no, then I have no option because she will be the one to pay for the cost of my education. My mother said her decision was because she wanted me to be a military woman, so I needed to do a course and work to push myself, so the STEM course was better than those female courses.

(Fen)

The actions of these two mothers, especially the mother of Fen, were unexpected because, culturally, most Ghanaian mothers are unlikely to act in this manner. Thus, as seen among the typical mothers reported in this study, Ghanaian mothers will validate and recommend their daughters to study fashion design and catering. Chua (2011) describes ‘tiger mothers’ as mothers who show deep involvement in their children’s achievement and pressure them to succeed in specific life areas, such as education. From the narrative, it is difficult to explain the differences between mothers with economic authority and those without it. Regardless, it is possible to explain that mothers with economic authority and autonomy are already not conforming to traditional economic standards. Therefore, it is not surprising that they would support and encourage their daughters to make non-conformist choices, which could potentially increase their economic outcomes in the future.

The finding on the role of parents in education and career decisions is consistent with research that has found that social individuals, such as parents, influence the attitudes and preferences of young people (Archer, 2014). Sjaastad (2012) describes these actors as significant persons who were family members and who function as validators and invalidators of these young women’s STEM-related TVET choices.

However, the findings on fathers’ validation for STEM-related TVET courses have contradictory evidence in the literature. For instance, the findings contradicted earlier studies, such as Agbley (2015), which found patriarchy as a reason for young women’s under-participation in STEM-related TVET courses. Unlike the fathers reported in Agbley (2015), the fathers of these participants used their privileged position of economic power or authority in the family to consolidate and affirm the participants’ non-conforming decision to study STEM-related TVET courses. Meanwhile, the finding on fathers being validators of STEM-related TVET choices rather than mothers confirmed similar research, which found that women in STEM described their fathers as more supportive of their decision to study STEM than their mothers (McEwen, 2013). Mothers’ preference for their daughters to study fashion
and catering conformed to gender stereotypes that constrain educational choices (Archer, 2014; Eccles et al., 1994). One potential interpretation is that mothers, unlike fathers, were not seen as financiers of young women’s education and were not primary consults for education and career choice validation. A typical example is noted in the narrative of Ata, which said:

As for my father, I told him before choosing the schools. When I finished, then I told my mum and my auntie. I know that my father will support me and pay for any expenses, although we do not have enough money. (Ata)

Generally, research shows that parents significantly influence the STEM choice of their children (Archer et al., 2015; Chi et al., 2017; Rozek et al., 2017), and different factors influence parents’ decisions to support or not support STEM aspirations. For instance, the literature shows that parents’ understanding of the utility value of studying STEM, which is an element of the EVT model, considerably influences their encouragement of their wards, especially girls, to study STEM and aspire for STEM careers (Ardelt & Eccles, 2001; Frome et al., 2006; Šimunović et al., 2018).

However, what has been understudied is which parent or family members are most influential and under what social, cultural, economic, or political conditions? From this finding, it is plausible to explain that economic actors in the family are highly likely to have the authority to validate young people’s education and career choices. Mothers, who are unlikely to be the main economic actors or heads of families in Ghana, are unlikely to invalidate their daughters’ STEM aspirations. It seems that these mothers expected their daughters to conform to traditional standards, or these mothers may not know the advantages and utility values of young women in studying STEM-related TVET courses.

5.1.4 Reinforcers and Underminers

The participants reported that other social actors who were divided into two groups, reinforcers and underminers, influenced participants’ STEM-related TVET choices. The participants’ narratives seemed to describe reinforcers as social actors such as other family members, teachers and community members who positively influenced their STEM-related TVET decisions. These reinforcers usually used words of encouragement and sometimes provided economic support to reinforce participants’ choices. Uncles and elder brothers seemed to be the most common economic reinforcers. In most cases, it appeared that uncles and brothers provided economic support when the participants' parents were unavailable, particularly when the parents were divorced, or the father was deceased. Ami, who received financial support from her older brother, explained:
My senior brother made comparisons, and he said the secondary school is purely about theory and reading books. However, I would do the theory and practical parts when I went to a technical school. The practical part is more than the theoretical part. Moreover, I get the skills to work at the end of the day. He said I could do things with my hands and work for myself. Lastly, I can also be creative. (Ami)

Ayi, whose uncle financed her education, narrated:

It was my uncle who helped me choose my course. He told me that nowadays, everything is technology so information technology would be helpful to me in the future. My eldest brother also told me I should change my course to IT. (Ayi)

Only one participant reported that her old sister was the economic reinforcer of her decision. This was Yaa, who said:

Only one of my siblings (my senior sister) encouraged me to come here. She is the only one who is taking care of me among the rest of my siblings. She is doing Kayayo (head potter) in Accra and caring for me. (Yaa)

Apart from economic reinforcers, participants reported that there were other social reinforcers whom they described as role models. Role models were reported as having used their knowledge and experience in STEM-related TVET education or occupations to provide positive reinforcement for the participants. The participants’ narratives showed that the primary role models were older brothers, sisters, and community actors. For example, an electrical engineering learner, Ako, explained:

My brother also went to a technical school to study electrical. So, I became interested in what he was doing. So, I followed him wherever I went when I was going to work; I was there to watch what he was doing. I had a fair knowledge about electricals through observations before coming to school to study electrical engineering. I used to observe my brother at work and ask him about electrical engineering. (Ako)

Evi shared a similar story about her brother:

My brother influenced me about the technical school, but I decided on the programme. My brother was mostly talking about technical school. He said technical schools were more practical than SHS. He said that I have my work with my skills after technical school. My brother also attended the same
school to study building construction. He builds people's houses. My brother influenced me about technical school. (Evi)

There was one instance in which a participant reported that her senior sister reinforced her STEM-related TVET choice. Fen reported that her senior sister in the STEM-TVET field was the role model that reinforced her STEM-related TVET decision:

My senior sister is in her third year; she told me something small about electrical engineering. So, in JHS, I observed her when she was doing practical lessons at home. I used to stand and watch her work even before I came to school. That exposure influenced me about technical school. (Fen)

Furthermore, participants also reported that there were instances where community members functioned as role models. These community role models were usually owners of local STEM-TVET workshops or employees of local STEM companies, such as mining, in the participants’ communities. Aki reported:

I also asked a man in my area about technical education. He is called master Kofi; he has a welding workshop near my house. I asked him, and then he told me I could do it. So that pushed me. He is my friend and a welder in my community. (Aki)

Aku reported:

My father always tells me about a woman who works in my town’s manganese company. He described how they hold her in high esteem and love the woman. He also talks about how she is a great planner for their company. So, one day the company came to our school to encourage young girls not to be afraid of doing these engineering courses. The woman advised us against girls’ fear of STEM programs with maths, science, and engineering backgrounds. So that also encouraged me to have a passion for engineering. (Aku)

Participants described other educational reinforcers, usually teachers’ who influenced the STEM-TVET choice of participants with positive socialised perceptions and information about the participation of young women in STEM-related TVET courses. For instance, Evi explained:

My teachers said that even if I go to technical school and do a male-dominated course, after secondary, I can have my workshop, and it could be straightforward for me to get a job. So, I should try hard and push myself into a technical school. … in this world nowadays, it is tough for you to find
a job, so if I attain a technical education, I can gain something (skills) to
work (Evi).

Amo reported:

My pre-technical drawing teacher explained that I would have the skills to
work after a STEM education at a Technical Institute. However, for instance,
if I go to grammar secondary school to study general arts, home economics,
business, or even general science, I may not get a job after school. However,
you will likely get skills at a technical school. (Amo)

The two cases depicted how most teachers influenced and reinforced participants’ STEM-
TVET choices and encouraged them with scenarios that conveyed optimistic future
outcomes.

On the other hand, participants reported that underminers were social actors who
negatively influenced their STEM-related TVET decisions. In the case of these participants,
underminers were usually older sisters and female friends who used negative reinforcements
such as negative perceptions about women and girls in STEM and discouraging words from
discouraging the participants from making their STEM-related TVET choices. Like mothers,
most senior sisters appeared to undermine their decision to study STEM-related TVET
courses. These sisters usually undermined the participants’ STEM-related TVET decisions
with discouraging language that expressed their doubt about their capabilities to study
STEM-related TVET courses. A typical example is noticed in the following narrative from
Ala:

When I was asking my mum about my decision to study engineering course,
my senior sisters heard me. She then said [name], so why do you think you
can do an engineering course? She told me I could not study the courses
because it was challenging and a girl like me would find it challenging to
study, so I should not choose an engineering course. (Ala)

Female friends appeared to discourage participants’ STEM-TVET choices by
expressing negative beliefs about young women’s participation in STEM-related TVET
courses. Ami explained that when she told her friends about her decision to study STEM-
related TVET courses, they said:

Anyone who studies computers will be a scammer in the future. (Ami)

Two other instances were reported:

You often heard people, especially my girlfriends saying that engineering
courses are lower-grade courses to offer. My friends said that if I studied
accounting and other courses, which could give me more opportunities and money than engineering. (Ala)

Aku stated:

Even before I came here, I heard rumours from my neighbours that people who attend technical schools are not intelligent and do not know anything academically. They are not good in school, so they ran from general science and the other courses in grammar schools.

The finding on the role of other family actors was consistent with research that has found that some social individuals influenced the attitudes and preferences of young people (Archer, 2014). Like fathers and mothers, these individuals can also be described as significant persons (Sjaastad, 2012). The finding contributes to the knowledge that a cultural world can reinforce or undermine fathers’ and mothers’ validations and invalidations. The finding on the reinforcement of uncles and older brothers appeared to align broadly with the validations of fathers. In contrast, the undermining of senior sisters appeared to align with mothers’ invalidations. These older sisters’ preference for non-STEM-related TVET courses like fashion and catering instead of STEM-related TVET courses conformed to gender stereotypes that constrained these young women’s educational choices (Archer, 2014; Eccles et al., 1994).

There is patchy and conflicting evidence about the effectiveness of influencers and role models in changing STEM education and career stereotyping (see Conner & Danielson, 2016; Gokpinar & Reiss, 2016; Sheldrake et al., 2019). The current findings consistently show that role models influence education and career decisions. For instance, research about apprenticeships in Ghana found that young women who chose STEM were positively influenced by successful role models in STEM trades (Aryeetey et al., 2013).

Further, the findings support the evidence that gender role models do not significantly change STEM stereotypes. Instead of the success of role models, the consistency of encounters, the access to roles and the embodiment of STEM by role models are the significant factors that influence young people (Haynes et al., 2013; McGuire et al., 2020; Means et al., 2016; Musset et al., 2019; Sibbons & Seel, 2000). Therefore, as found in this research, regardless of gender, STEM role models were relevant to STEM education and career decisions. Finally, this finding was consistent with research that shows that exposing learners to people from the world of work challenges stereotypes and raises aspirations (Hutchinson, 2018; Lee et al., 2019). The primary argument is that exposure to people from the world of work positively impacts education and career decisions by breaking the visual
circle of gender stereotypes and increasing social mobility for disadvantaged youth (Mann et al., 2014; Mann, Rehill et al., 2018).

Again, a potential interpretation appeared that teachers knew about the relevance of young women’s participation in STEM-TVET fields and used that as relevant information to reinforce participants’ choices. This interpretation is well aligned with skills development discourse, which suggests that TVET is a passport to employment. However, the relevance of young women’s participation in STEM-related TVET careers in the future is a complex process that requires other systems, such as the labour market, to be favourable for young women to flourish (Barrick, 2019; McGrath et al., 2019; Tikly, 2011, 2013a).

The finding on teachers as reinforcers was consistent with research showing that teachers’ beliefs, knowledge and positive perceptions about STEM encouraged young women to study STEM effectively (Gunderson et al., 2012; Li, 1999; Mujtaba et al., 2018; Sadler et al., 2013). Mujtaba et al. (2018) found that encouragement from teachers positively associated with aspirations was a significant factor for STEM choices, even when family science capital was absent. The narrative about STEM-related TVET learners being academically weak compared to STEM learners in general education was consistent with a Greece study. The study found that young people in STEM-related TVET pathways were perceived to have been rejected by general academic schools because of their poor academic performance (Christodoulou, 2016). The general negative perception of TVET and the poor academic achievement of TVET learners is well documented in the literature (Dadzie et al., 2020; Ngugi, 2017; UNESCO-UNEVOC, 2018; Zirkle & Jeffery, 2019). This evidence on reinforcers and underminers was consistent with Eccles’ (2011) socialiser’s beliefs and behaviours. These socialised beliefs were positive and negative perceptions based on social roles, norms, genders and socialisations (Eccles, 2011a, 2011b). The findings were also consistent with the EVT model's cultural milieu and socialiser’s belief elements (Eccles et al., 1994; Neuenschwander et al., 2007).

In terms of reinforcers and underminers, the research suggests that the support and encouragement of other social actors were relevant in buttressing the young women’s STEM-related TVET choices. For most reinforcers, the roles they played stemmed from their economic capacity and their exposure to girls in STEM education or careers, which made them encourage these girls to pursue their STEM-related TVET aspirations. On the other hand, for most underminers, the role they played was because they held on to negative preconceptions and stereotypes about the participation of young women in STEM-related
TVET courses, usually because they were not exposed to other young women in STEM-related TVET courses.

5.1.5 Navigating School and Course Selection

Participants reported that in May of their final year of JHS, they chose their upper secondary schools and courses before they sat the BECE. They explained that they used the information received from the social actors to analyse their decision during the school selection process. For example, Awo explained how she contemplated the information received from the various social actors:

I had this conversation with myself that I had a monologue. I considered the information I had received about studying STEM-related TVET courses in technical schools… I concluded that offering a technical course would be the best. I do not get the reason doing technical school should be less. (Awo)

Amo reported:

So, I did not like a technical school, but when I chose my schools and courses, I compared the positive things my teachers said about technical courses and the negative things my friends said. I ignored all the negative concerns and chose a technical school to study a STEM course. (Amo)

It appeared that contemplating the information needed was a form of internal conversation (Archer, 2014), which helped these participants to reaffirm and reassure themselves that their decision was congruent with their long-term life project of becoming engineers through STEM-related TVET education.

Participants further reported that school and course selection involved three primary processes. The first step was to access the schools and courses register and form. The young women reported that in this first step, they had to access the school and course selection register from their principals at a fee. According to the participants, the registration fee was for administration purposes. The school and course selection register appeared to be the only official document containing all secondary schools and courses in Ghana. Participants reported that the register guided them to choose the specific technical school they had identified. The register also provided general information about the schools, such as gender, day or boarding status, the courses offered, and the school region, district, and category. In particular, the school category showed each school’s general performance and infrastructure level, and the categorisations from A–E with A–D representing the ranks of senior high schools and E representing pure TVET schools without any ranking (Ghana Education Service, 2021). As Evi narrated:
We were given the register to select the schools and courses. I was thinking of doing the specific technical course in the schools I wanted to select. However, I learned that not all schools offer electrical engineering. I did not know until I looked at the school and course registration. (Evi)

Awo said:

I received a big book containing the SHS and the technical schools. There were pictures. So, I started with the technical schools, thinking about the type of school I wanted. (Awo)

Although using the register aided participants’ school and course selection process, participants reported that there seemed to be inconsistencies and constraints within the process. The complexities were associated with instructions and guidance during the process. For instance, while seven young women narrated that their schools permitted them to select only technical schools without any concerns, other participants were restricted from choosing only pure technical schools. Aba narrated:

When we selected our schools, we were told we could not select only pure technical schools. (Aba)

Ala, also shared that her teachers restricted their selections, saying:

Our teachers said that we have to choose from distinct categories and at least one of the schools should be within the Central region. We do not have to choose schools far from the central region. (Ala)

Participants explained that they did not expect these forms of restrictions. Aba, in particular, found the restriction in the selection process surprising since she had expected none of the restrictions. There are two primary anecdotal explanations deduced from the young women’s narratives. The first explanation appeared to be that schools were looking out for the best interests of these young women, especially when it came to proximity. However, because these participants were average in terms of academic achievement, the schools wanted them to play safe by choosing various schools and courses that could increase their chances of gaining admission. The second potential explanation is that certain teachers and headteachers appeared to not believe in the capabilities of the young women. Therefore, they needed to encourage the young women to consider other available options that they perceived were suitable for these young women.

The second step was filling out the form and submitting it for school and course placement. Participants reported no defined structure for completing the school and course selection form. Although the register had selection instructions, this did not provide
uniformity. For instance, professional guidance and counselling services were generally lacking. However, there was one case in which a participant, Eku, received guidance and counselling from external counsellors during the school selection period:

A guidance and counselling personnel team came to our school to advise us. They told us the Ghana Education Service sent them to advise us about school and subject selection. We asked them questions, and they answered us. I went to a government school in Accra. (Eku)

One possible explanation was that principals of public schools and proprietors of private schools had the autonomy to decide the school selection process, which could have influenced the lack of uniformity. School culture and resources determined how schools managed the selection process. Schools with more resources, such as counselling provisions, were more likely to ask students to fill out school forms.

Participants reported that the ultimate step was to accept or reject the school and course the Ghana Education Service offered. The narratives showed that school placements were released some weeks after the release of the BECE results. After releasing school placements, learners checked their placement using a mobile code on the phone or the internet. Twenty-three of these young women studied accepted their placement in a Technical Institute to study STEM-related TVET courses. Shi shared her experience of how she received her placement news:

I was unhappy about my grade, so I was terrified of not receiving a placement. However, I was happy about my placement when I noticed I was accepted to study Building and Construction Technology at CCTI. I accepted the offer and went to the school to start enrolment. (Shi)

However, as mentioned earlier, three of these young women appeared to be navigating a more unusual terrain. No matter the extent of planning that perceived this journey, not all of these young women had a linear start. The first case was Shi, who reported she had to change her course after starting a non-STEM-TVET course in a technical school. Shi wanted to study general arts but was in a technical school to study catering. After studying catering, she noticed that she could not afford the expenses. Hence, she compared catering to other courses in the school and decided to choose STEM-related TVET courses with little or no expenses. After consultations with her teachers, she chose refrigeration and air-conditioning technology. Her decision was supported by the teachers, who assisted her in successfully changing her course. She narrated why she changed her course and the experience:
I decided I could not continue the catering programme because my parents were poor. Sometimes, telling them about the expenses and ingredients, I needed for catering practical lessons was difficult. So, I observed for a while and noticed that the engineering programs had low fees associated with the practical lessons. So, it is based on this observation that I changed my program from catering and hospitality to refrigeration and air conditioning technology. (Shi)

While Shi changed her course based on her low-income background, with little influence from her parents, Ajo, on the other hand, changed her course and school because of her mother’s advice about potential employment opportunities associated with STEM-related TVET courses. She narrated that ATI was her second placement. She started school in another secondary technical school, but her mother was unhappy about the placement. So, she applied for a school transfer and finally received admission to study agricultural mechanisation technology at ATI. She narrated her experience:

I agreed with my mother to change my course to agriculture …. So, so they transferred me here to study agricultural mechanisation, where I can do practical lessons and add theory. So, I feel comfortable over here. I choose to stay here. (Ajo)

The third case was that of Ama. Unlike the two other cases above, she did not accept her placement. Fortunately, the only available option was a STEM-related TVET course in a technical school. Hence, she had no option but to accept the available offer:

I did a self-placement after rejecting my offer. The available course was database management systems for girls. I decided to do database management systems. (Ama)

Generally, aside from Eku, who received guidance and counselling for the school and course selection process, the findings showed that the participants decided on their school and course selection without adequate guidance and counselling from experts, as noted earlier. The insufficient expert information about programmes, careers, schools, and courses seemed to explain why participants sought validation and invalidations from social actors to guide their internal conversations. Unfortunately, the expectancy-value theory of achievement-related choice fails to capture guidance and counselling in the choice model. However, the evidence showed that guidance and counselling services could have a critical enabling impact on education as an achievement-related choice.
Although the flexibility to change educational choices is not widely discussed in the literature, the finding was consistent with other evidence, which shows that young people may want to change their constrained choices when they have the opportunity to do so (Latina, 2017). The relevance of horizontal and vertical permeability in education, especially in VET systems for young people, is noticed in the Swiss VET system (Latina, 2017; Zirkle & Jeffery, 2019). The primary argument is that incomplete information about educational routes, courses and evolving aspirations can make young people decide to switch between educational pathways (Latina, 2017). As seen in this research, there was much horizontal permeability among young women, and the flexibility to allow that change was significant. One of the consequences of this permeability is the diminished academic and vocational educational divide (Zirkle & Jeffery, 2019).

Moreover, the narratives of these three young women showed that the goals, general self-schemata and self-concepts of young women proposed by Eccles (2011b) could change in the face of constraints and enablers. These components are not final nor fixed but highly amendable, depending on the situation. This explains why it is essential for TVET systems to be flexible to meet the changing identity and general sense of direction among young women. It is easy to focus on the complexities of these young women’s situations. Nevertheless, it is essential to note that these young women show prominent levels of agency in the face of these constraints, and their interaction with the people and the situation proves their agency. From a sociological perspective, Hodkinson and Sparkes (1997) use Pierre Bourdieu’s concept of field and habitus to conceptualise career decisions among young people as careership. Their study shows that career decisions that extend education and training are not made in isolation from social, cultural, and economic situations. Instead, it is a complex process that sees an interaction between structure, agency, and choice in what they discuss as the horizon of action. As they explain:

The various elements that make up this model of careership cannot be separated except as an analytical device. Everything takes place within a macro-context with social, political, economic, cultural, geographical, and historical dimensions. Within this is the field, with its interactions, power struggles, alliances, and negotiations, where those interactions and the formal regulations determine the game’s rules. People make pragmatically rational decisions within a field within their culturally-derived horizons for action at turning points. (Hodkinson & Sparkes, 1997, p. 41)
Although most of these young women appeared to experience a linear planning process, the three atypical cases prove that education and career choices are not simplistic predetermined conditions or linear processes enacted by individuals or societies. Instead, young women’s education and career decision can be subjects of foreseen and unforeseen changes.

5.1.6 Retrospective Affirmations

Retrospective affirmations were the elements young women identified as most explicitly or implicitly influential on the STEM-related TVET pathway decision. In retrospect, participants narrated that there were two explicit factors were influential in choosing STEM-related TVET courses as the right pathway. These young women affirmed that their positive subjective experiences during practical learning and their expectation of success in the labour market were the explicit reasons for their decisions. Participants had identified that the practical learning mode, which allowed them to learn by doing, was why the STEM-related TVET pathway was the best educational choice retrospectively. As Esi said:

My experience so far in these technical schools has provided me with more practical engagement practical lessons. That was why I chose technical schools, and my enjoyment confirms that this form of education is for me. For example, every week there are practical lessons. Mondays and Thursdays we have practical lessons. However, in secondary school, I have heard there are no practical lessons; the theoretical lessons are. (Esi)

Participants’ reports can be understood from three different viewpoints. First, it appeared that for these young women, a practice-based approach to learning helped them develop a sustained interest in and enjoyment of their courses and to give them full attention. Figure 5.1 shows two participants excited about practical lessons day. The practical experiences seemed to be a significant factor in the participants’ success on their STEM-related TVET journey. They needed to focus their attention on the design and making processes. Second, the practice-based approach to learning allowed the participants to explore their creativity. As noticed in the narrative of Ayi above, practical lessons were an opportunity for her to be creative.
Therefore, it seemed that theoretical approaches to learning would not have been an ideal way for these young women to express their creativity, which made STEM-related TVET courses the best option. Finally, it seems that these young women had the aptitude to use their hands and skills to express their intelligence. Although generally, these participants were average-performing students, they appeared to believe that the practical learning modes provided opportunities to express their intelligence through the things they could design and create as STEM-related TVET learners.

The second subjective retrospective affirmation was their expanded possibilities of future employability outcomes. Participants narrated that, despite the stereotypes about the participation of young women in STEM-related TVET courses, they were convinced of the positive career outcomes, which were highly likely to result in good economic outcomes. For instance, Ako stated:

I have not seen any lady electrical engineers at work, but I know some women engineers. There are young women around who are doing electrical engineering, and I know that ladies like me are in technical schools and would be working, and at least my seniors who did the course before me are working and making money. (Ako)
The availability of work opportunities in STEM-related TVET fields and accompanying economic outcomes were most prominent among the three participants who lived in mining communities. Aba reported:

One company in our village is a mining company. I have studied the company very closely, and they have no girls. It sounds like maybe, after completion, I can go there and start my career there. (Aba)

Aku, Ata, and Amo, all from mining communities, expressed similar aspirations to work in mining companies. Ata emphasised that there were women already working in the mining sector. Sometimes, when she saw women in the mining sector, especially on the bus to work, it inspired her and made her happy. In concluding her narrative, she stated:

It makes me proud of the course I chose to read, and I know I can work in that company one day after my course. (Ata)

A group of these participants also drew links between STEM-related TVET courses, entrepreneurship, and positive economic outcomes. These participants were convinced that after completing STEM-related TVET education, they would possess skills and competencies to help them become entrepreneurs. The value of having skills and competencies through technical education served as a dual passport to economic outcomes, a passport for employment in a company or a passport to entrepreneurship. Winch (2013) argues that compared to general education, TVET is attractive because it gives employment and further education accreditation. This implies that these young women’s attraction to STEM-related TVET courses because of increased employability was a rational decision that granted other possibilities. Thus, whereas young women studying STEM in senior high schools could progress to higher education, these young women could dream of accessing both the labour market and further education. For instance, these participants suggested they considered working as entrepreneurs with STEM-related TVET certificates to save money for higher education. Esi reported:

With my STEM certificate, I know that even if I cannot continue with the university, I can do something (work) for myself and save money for university. It is why I chose this course in a technical school. (Esi)

Similarly, Shi said:

I am sure I could find a job or start my job as an electrician with the skills I have developed. (Shi)
Although the employability affirmations appear to be linked with the human capital assumptions regarding education, they do not mean the same for these young women. These young women considered employability to have achieved two primary goals. Their goals were to actualise a future career as an engineer or a military person, and second, they were to use the income for their flourishing. As noticed in Esi’s narrative above, flourishing included saving money for higher education.

Finally, some participants appeared to report that there was an implicit influence of free SHS and TVET policy on their decision. It was especially the case because most young women where from low-income family backgrounds who could have not afforded their technical training without the offer of free education. Although majority of the young women did not explicitly report free TVET as influential, there were case where young women indirect referred to the impact of the policy. For instance, Aki, explained that she was placed in school because of the free SHS system. Her reason was that, because all upper secondary schools were free, she had the freedom to choose any course and pathway of her choose without the extra burden of the cost. In another instance, Eku explained that:

When I was in JHS, I didn't know there will be a free SHS opportunity, by God's grace I had the opportunity to go to school for free. I don't believe someone from somewhere can come to my aid. I believe it's been beneficial to me this is because I would not be able to attend technical school if it wasn't for the free SHS. Even if I would have been to school, it wouldn't have been immediately after the completion of JHS. Others stayed home for a while to prepare for school. But the free SHS has helped many ways, so the money I personally worked for with the aim of paying my school fees was added to what my family could provide for me to school. When I came to school, I didn't pay admission fee or any other fees. The school uniforms were given free school class and those books and exercise books, and notebooks were given for free. The books were not enough so my family had to top up and we were given supporting the items.

Similarly, Ako explained:

It was not easy for me, there were a whole lot of challenges when I came. and even when I completed JHS it was difficult for my parents to admit me
here while it was free SHS. Although it was free SHS it was not easy at all. They felt a little disturbed. They all needed me to go to school but was not enough financial in the house. They were trying to tell me to go out there and learn a trade. But I insisted no, I will go to school. As far as there is free SHS I know I can do it. (Ako)

Although most of these young women did not allude to free SHS as one of the reasons why they chose technical schools. Research on Free SHS high education in Ghana has shown that the policy has positive impact on the educational trajectory of young people which in this case includes young women. In an evaluation of the Free SHS policy, Mohammed and Kuyini (2021) explain that the Free SHS Policy which provides education free basic and secondary education in its entirety has increased demand for secondary education. Participants explained that they came to this realisation by comparing the learning mode in senior high school to the learning mode in technical schools. One participant shared that the unique nature of learning in school-based workshops and having internship opportunities during vacation was a reason to affirm their decision to be the best. For these young women, the emphases were on their ability to use their ‘hands’ to learn and solve problems creatively. Ami expressed her retrospective affirmations subjectively:

If I had gone to senior secondary school, I would have read books and studied theories. Everything is in theory. Now that I am in a technical school, I have more practical lessons; practical lessons are more than theoretical. Moreover, you get skills to work and can also be creative. (Ami)

These retrospective affirmations appeared to have developed from internal conversations these young people had with themselves to identify why the STEM-related TVET pathway was their best and most attractive education choice.

The findings that participants found a practical learning mode to be an affirmation of their choice aligns with Dewey’s philosophy of obtaining knowledge through practical experiences (Sadovnik et al., 2017; Winkelman, 2016). John Dewey (1997) argued that positive experiences obtained through practical lessons sustain interest in education. Awo’s account of her experiences confirms the power of positive experiences: she learned how these
experiences engendered her attraction to STEM-related TVET courses and showed that this was the best educational option for her. The finding further aligns with the utility task demands in the expectancy-value model. The core argument of the utility value component of the EVT model is that when a task is considered relevant to young people, that task can be subjectively evaluated as a significant source of motivation, interest and value (Eccles & Wigfield, 2016).

Finally, the findings show that most internal conversation processes compared technical and typical characteristics in general education. Internal conversations in the form of comparisons were consistent with the multi-attribute decision-making (MADM) argument (Yoon & Hwang, 1995). As argued by MADM theorists, participants reported they evaluated different information about the two school options available to them to make their decisions to pursue STEM-TVET education. Mainly through the lenses of the MADM, it appeared that, in retrospect, participants evaluated and analysed multiple attributes of education pathways and selected one option they subjectively valued as the best for them (Ding et al., 2016). Although Harte and Koele (2001) argued that decision-makers need all the relevant information about alternatives to decide, it appeared that, in hindsight, participants admitted they did not have all the necessary information about schools and courses. These young women reported that although they had identified practical learning and employability outcomes as the primary reasons for choosing STEM-related TVET courses, they did not necessarily have adequate information about schools and courses before deciding. For instance, most young women did not know the location of their schools, and others did not know the available infrastructure in their chosen schools. Regardless, the participants reported making decisions based on the limited available information, of which the practical learning approach was fulfilled as anticipated. They appeared to believe that their chances of employment increased after completing their course. Figure 5.2 provides a pictorial map of how these young women planned their STEM-related TVET choice.
5.2 Theme 2: The Dual Experiences of Young Women in STEM-Related TVET

This theme represents the lived experiences of participants as STEM-related TVET learners. The theme engaged the life world of participants as minorities studying STEM-related TVET courses in technical schools in Ghana. It is important to note that the first-year participants did not report extensive lived experiences as STEM-related TVET learners because they had just started their course at the time of the study. Participants made sense of their lived experiences through a sense of navigating enablers and constraints. These lived experiences navigated by participants were classified into enabling experiences and disabling lived experiences. Enabling lived experiences focused on fulfilling and valuable experiences such as academic support, encouragement, and practical engagement that participants navigated. These disabling lived experiences focused on challenges and disadvantages navigated by participants, such as academic challenges, lack of female STEM-related TVET teachers, inadequate infrastructure and materials, limited work-based learning, and verbal bullying. These lived experiences aligned with the ‘child’s interpretation of experiences and the affective reactions and memories of the expectancy-value theory model (Wigfield & Eccles, 1994).

Nevertheless, the disabling experiences, such as verbal bullying, supported the assumption that each choice has a relative cost. Wigfield and Cambria (2010, p. 40) emphasised that “both negative and positive task characteristics influence choices. All choices are assumed to have associated costs because one choice often eliminates other options.”
5.2.1 Enabling Lived Experiences

The enabling lived experiences of these young women focused on the three core positive experiences these young women reported having had as STEM-related TVET learners. These positive experiences have strengthened these young women’s decisions to retain their STEM-related VET courses and aspirations to be engineers and related professionals.

4.2.1.1 Academic Support.

Participants reported that, as average-performing students, they needed and received sufficient academic support in school. For instance, Ado shared:

Some of my class members had good grades, but I believe I did not make good grades in the BECE. Because of that, I knew that I would need help from my teachers to perform better. (Ado)

Participants reported that they had not performed exceptionally well on the BECE and had no prior experience in STEM-related TVET courses; they anticipated needing additional academic help from their teachers to complement their efforts. Ami said:

I had not tried welding before I joined the welding course. Therefore, I knew I would also need help with the theory and practices. Soon, I knew I could learn about welding with the help of my teachers. (Ami)

Furthermore, most participants interpreted the academic support they received as a necessary measure to ensure their success. Participants came to this interpretation because most academic support appeared as a form of special attention that the young men on the programme were perceived as not receiving. Aki explained:

Whenever our practical teacher teaches us, he makes sure that I understand, and whenever I do not understand, he pays extra attention to the topic even if the boys understand. (Aki)

In addition, a group of these participants interpreted this special treatment as an inclusive approach. Although these participants received special attention, it was an approach to ensure they, as minorities, would actively participate in every academic activity. Ago went on to say:

Like when my teacher teaches and I do not understand, I would ask him during his leisure time to explain in detail. So, there is no discrimination. I do not feel the boys do more than I am allowed. We have the same if not more opportunities to practice than the boys. (Ago)
The interesting finding here is that academic support was provided not only by teachers; the majority of male learners were also instrumental in providing academic support for these participants. Shi related:

Our class is inclusive; the girls can do whatever the boys do. Even if you do not understand a class topic and approach the boys, they are usually ready to support you. Sometimes if we have work in technical drawing, and I do not understand or cannot work it out, the boys approach me willingly to support me. Their actions encouraged me and made the class inclusive. It makes me feel accepted. (Shi)

The finding on academic support was consistent with the literature that shows that positive experiences such as sufficient academic support can represent a source of motivation and persistence among young women in STEM. The findings contributed to existing research that has found that girls’ persistence in STEM courses is positively associated with a supportive environment created by teachers and peers in school (Koch et al., 2019; Ngugi, 2017). Notably, positive emotional experiences in class can lead to determination and high engagement in STEM courses (Dorph et al., 2018; Shirazi, 2017). The finding raises a critical question about what conditions could elicit such supportive environments. Participants’ agency to achieve their life project elicited positive support from their male peers and teachers. Gläser-Zikuda et al. (2013) argue that a supportive environment in the classroom can help define students’ emotional consciousness and facilitate students and teachers to reflect upon their actions and instructions in the classroom.

4.2.1.2 Encouragement.

Participants interpreted specific enabling experiences as sources of encouragement. These young women explained that an enabling experience was a form of encouragement when it positively impacted their decision to stay on the course despite the challenges. Shi explained:

My positive experience made me decide to stay on the course. It was not easy, but I was willing to put in all the effort. Usually, when a teacher asks us to perform a task, the boys will help us. For instance, if it is about mixing mortar, we all do it together. Usually, the boys go and bring cement, and I join those mixing the mortar. It is also about mixing concrete; I do that as well. (Shi)

Moreover, participants reported three primary encouraging experiences. The first was encounters with older students, especially females; the second was with alumni who study
STEM-related TVET programmes in a technical university, and the third was STEM-related TVET outreach programmes. First, participants reported that they found it encouraging when older students shared subjective experiences because their shared stories provided some reassuring guidance on their expectations of success. Awo narrated:

I came to the school with an aggregate of 23, but when I came here, my school father [male senior], who also came here with an aggregate of 24, approached me … So, he shared his story with me, and I also shared mine with him. So, as we compared our stories, I knew I was in a school with bad grades, but I could still make it with hard work. (Awo)

Ofa shared a similar story:

Fortunately, I had a school mother [a female senior] from a low-income background when I came to school. Moreover, because she knew she was not from a wealthy family, she lived a simple life, which also helped me live my life. My school mum would always advise me to use her own life as an example. I should be patient and study well so that everything would be well. (Ofa)

Furthermore, participants reported that opportunities to meet alumni were encouraging experiences. It appeared that alumni were either recent male or female students who had graduated from the school. These alumni either had contact with these young women or visited the schools to advise the young women. Afi told the story of one significant encounter:

Three students who finished last year came here two weeks ago, and one had completed the architectural drawing course. He explained the components of our course to my classmates and me. We were talking about civil engineering, building management, and surveys. Well, I had an interest in building technology. So it was that information that helped me decide what programme I wanted to study at the university. (Afi)

The final source of encouragement was encountering women in STEM-related TVET pathways at a higher education institution through an outreach programme developed by the University of Cape Coast for female learners studying STEM-related TVET courses in Technical Institutes. It appeared that this was not a regular school activity. Still, it allowed learners in CCTI and ATI to encounter well-equipped laboratories and see other women practise with that equipment. Awo described her experience:
We went to Cape Coast Technical Institute, university, to other young women in male-dominated [STEM-related TVET] courses. It was a memorable experience. We talked with their teachers over there, and I learned that… particular lady encouraged us that it is excellent for a lady to be in a technical school. Because it is a privilege, we can get into any job we like when we complete school. Moreover, I learned that you could do your job if you learned electrical engineering. (Awo)

Ayi narrates a similar experience:

All the girls were doing boys’ courses, and we went for a Cape Coast Technical University workshop. I learned what I could do at the university, and the girls there encouraged us to continue the course. Because she has made it, she is doing what she is doing now. So, every year, we all go to the Cape Coast Technical University workshop for the girls doing boys’ [STEM-related TVET] courses. (Ayi)

Unfortunately, DTI and EATI did not offer external encounters with university institutions. It is not explicit from the narrative, but one possible interpretation was that there could have been no collaborative networks between these Technical Institutes and the technical universities in their regions.

Although these encounters were not school-mediated or intended aspects of the curriculum, the finding was consistent with research that found that positive encounters with outsiders, primarily through outreach programmes, positively influence learners’ confidence and self-concepts (Beicht & Walden, 2017; Mann, Kashefpakdel, et al., 2018; Musset, 2019; Percy & Kashefpakdel, 2018; Tsybulsky, 2019; Yu et al., 2020). For instance, Koch et al. (2019) found that engaging outsiders and insiders (who appeared to be alumni, seniors and women in STEM-related TVET pathways in technical universities) to encourage young people is successful in influencing their persistence in STEM courses.

According to participant interpretation, the potential effect was that these positive encounters that were vulnerable to these young women appeared to contribute to the retention and persistence of participants. The emphasis was that these short-term positive encounters had a positive long-term effect on the participants. For this reason, Tsybulsky (2019) argues that the concept of positive experience drawn from Dewey’s idea of positive experience can lead learners to develop long-term positive outcomes in the form of skills learned.

Furthermore, the finding is consistent with social capital researchers, who have found that access to social networks through relational proxy actors such as volunteers is necessary to
create an enabling environment for young people to create social change (Beicht & Walden, 2017; Koch et al., 2019; Yu et al., 2020). In this research, because most schools were in rural communities and learners were from low-income backgrounds, access to social networks in school was essential to participants. It might not be the case for other young people from high-income families with parents of high educational backgrounds who can create social networks.

However, the case of learners in DTI and EATI presented a concern as these learners could not access such social networks. Galliott and Graham (2014) argue that smaller schools in disadvantaged areas (which appeared to be the case with DTI and EATI) are highly likely to have limited social capital and may struggle if schools do not intentionally provide such social networks. Studies show that social networks are great opportunities for students, especially disadvantaged learners. This is because these networks tend to provide disadvantaged learners access to resources and information that might not be available through family networks (Musset, 2019). Therefore, the finding showed that intentional school-mediated social capital opportunities through social partnerships with communities, employers, seniors, and higher education TVET institutions could be a source of encouragement for female STEM-TVET learners.

4.2.1.3 Practical Engagements.

Finally, participants appeared to report that practical work-based experiences outside school and hands-on learning experiences inside the school were enabling experiences. Ayi reported:

During one of our early practical lessons on hard drives in class, the teacher asked us to do it individually, and I was the first person to try, and I could do it. The boys clapped for me, and I was happy. (Ayi)

For most participants, having practical engagements either in school (as shown in Figure 5.3, where two girls were engaged in a building and construction practical lesson) or in the workplace with external employers was their first time being in an actual STEM workshop. ST3-EATI reported her experience:

We go to Ajumako for practical lessons. When we arrive at the shop, I move to the engineering side. For them, they do not work on tiny cars. They work on the KIA type, but I was working on a taxi when I went home and did an attachment. It is all the same, so I have to learn. (ST3-EATI)
Unfortunately, because the first-year students had no practical lessons during the interviews, they could not share any profound experiences associated with practical engagements. The second and third-year participants interpreted practical engagement opportunities as life-changing and fulfilling encounters. There appeared to be three primary explanations for the fulfilment expressed and the value attached to these practical engagements. First, the participants’ primary subjective value for choosing STEM-related TVET courses was the practical learning approach. Second, these practical engagements allowed them to identify real-life problems, design potential solutions and solve them using tools and equipment. Finally, practical engagements prepared them for the world of work by providing them with employable skills demanded by employers and self-employment.

Although there is a paucity of research exploring the voices of TVET learners about their practical engagements, such as work-based learning, numerous studies show that practical forms of learning prepare learners for the world (Aarkrog, 2005; Pang, 2015). These practical learning engagements help learners develop their skills and competencies and provide inclusive learning modalities. Also, they create a bridge between education and industry, thereby creating network systems that can encourage learners to engage more seriously in classroom learning, helping them link theoretical lessons to real work situations (Musset, 2019). The current finding was consistent with this existing literature and contributed by showing that practical engagements in TVET can be a great source of fulfilment and a retention factor for young women in STEM-related TVET pathways (King & Pringle, 2019).
Additionally, the findings contributed to existing knowledge by showing the relevance of the informal TVET (traditional apprenticeship) sector to skills development in the school-based TVET sector by being active social partners. Thus, as narrated by ST3-EATI, community-based employers in the informal sector provided their schools with work-based learning opportunities. This form of social partnership for work-based learning is relevant in rural and disadvantaged schools because it compensates for practical resource deficits. In Africa, where the traditional apprenticeship sector is large than the school-based TVET sector and where almost nine out of ten employers belong to the informal trade sectors, it becomes crucial for both sectors to partner for the overall benefit of learners (Akoojee, 2019; Benefer, 2007; Darvas & Palmer, 2014; Palmer, 2009a). The particular case in this study showed that these relevant partnerships were rare in an upper secondary school-based TVET. Therefore, Akoojee (2019, p. 7) argues:

Just as there is little engagement between the informal and formal economies, learning in and for this economy is more disparate than they need to be. More clarity about its key features and incorporation as a necessary component of national skills systems will advance its legitimacy.

In terms of enabling lived experiences, the research suggests that these young women experienced positive encounters as STEM-related TVET learners, seemingly leading to their decision to persist on their journey as STEM-related TVET learners. The various valuable experiences showed that beyond the support these young women needed to make their decision, they needed equal, if not extra, school support. This extra support received from colleagues and teachers, who were usually males, is discussed by Kuchynka et al. (2018) as benevolent sexism, where there is protective paternalism and complementary differentiation based on gender. It is expected that teachers support their students. However, the support from male colleagues was not an anticipated finding. Male learners’ protective paternalism is strongly associated with positive STEM outcomes for women who experience such positive stereotypes. However, it cannot be said that young women did not face any challenges. Therefore, this leads to exploring young women’s challenges in the next section.

5.2.2 Disabling Lived Experiences

Disabling lived experiences were negative experiences that challenged these young women. Participants reported that these disabling lived experiences were usually negative factors that constrained their agency and success as STEM-related TVET learners.
Figure 5.4: Illustration of Young Women’s Challenging Experiences

Source: Author

Figure 5.4 illustrates four challenges these young women navigated as STEM-related TVET learners. Challenges, such as inadequate teaching and learning materials, were not exclusive to these young women. Other male STEM-related TVET learners could have been experiencing similar challenges. However, there were other ways these male learners compensated for these shortfalls that these young women could not have navigated in the same way.

4.2.2.1 Academic Struggles.

Except for participants in computer programming courses that did not require manual technical drawing skills, most participants reported that technical drawing was one of the most demanding aspects of their STEM-related TVET education. Most participants interpreted their experience with technical drawing as tough. Ata narrated:

For the technical drawing, I struggle [giggles]. I am not good at drawing, but I try my best to draw… I could give my book to someone to draw for me, but I have to draw myself. (Ata)

Amo reported:

When I first came here, I asked myself, can I do it? I asked myself if this was the right choice because of how the course was, especially with the technical drawing. I could not understand anything with the drawing and the technical words they used. (Amo)

Further, inadequate prior training in pre-technical drawing appeared to be the main reason technical drawing was a challenge. Participants explained that although pre-technical drawing was one of the pre-technical and vocational courses offered in JHS, most schools did not make pre-technical drawing a preferred option. In most cases, schools offered catering instead of pre-technical drawing. Aki stated:

The drawing, especially the technical drawing, has small challenges because, in my JHS, I did home economics. (Aki)
Ala, who had always dreamt of studying engineering but who did not have the option to take pre-technical drawing in JHS, further narrated:

Concerning the technical drawing, I find it a little bit challenging because I did not offer pre-technical education at JHS. However, sometimes, when I am taught well, I put in the effort and can draw. (Ala)

Therefore, technical drawing was a challenge for participants who had no option but to study catering, as this had been the only course offered in their JHS. Even for participants who had taken technical drawing in JHS, inadequate teaching and learning materials and a lack of detailed training made the advanced technical drawing in Technical Institutes complex for them.

Another primary academic struggle participants mentioned was calculation. The main concern was that most participants were average-performing young women with weak academic performance in mathematics and minor or no knowledge about engineering calculations. Therefore, they struggled in these academic areas. Participants suggested engineering calculations were a new form of mathematics that they had to explore, and their basic knowledge of mathematics was inadequate for the level of calculations needed. Shi, who had already described her challenges with technical drawing, also shared a challenge in calculations. She answered:

Yes, one aspect that is difficult for me is calculation. Sometimes I do not understand the calculations at all. (Shi)

Afa also explained that although she was comfortable with the practical component of her mechanical engineering course, the theoretical aspects, especially those with calculations, were challenging. She added:

Here, I am not comfortable with the calculations. The calculation is complex.

The teachers teach me, but I do not understand as well. (Afa)

In the case of Aba, she was not explicit about her challenge with calculations and mathematics from the beginning. After further probing, she explained in detail, stating:

I do not get an understanding of these calculations. Sometimes, when given a test, I think what I have done is correct, but I realise what was wrong after marking. Nevertheless, since I started moving with the mathematicians in the dormitory, I have been coping with maths and trying to understand it and work it out independently. (Aba)

A strong relevance exists for manual technical drawing in STEM, especially engineering education. Technical drawing, in other instances, sketching, is a design tool in
these fields. Hence, participants in mechanical engineering, electrical engineering, and architectural drawing struggled; according to them, that struggle was a form of disadvantage. It is particularly so because research shows that manual technical drawing skills increase the mental rotation skills, transferable skills, personal achievement and enjoyment of engineering learners (Hui, 2003; McLaren, 2008; Ogunkola & Knight, 2018; Zainuddin et al., 2019). dos Santos et al. (2018) specifically explain:

The purpose of the Technical Drawing discipline in high school is the accurate and absolute representation of the forms in the three-dimensional material world. This is important to enable the spatial reconstruction of the form in drawing in the plan, and the project as a concise and unequivocally means of communication in projects (p. 484).

As dos Santos et al. (2018) explore, it could be important for teachers to try different learning and teaching methods that can make manual technical drawing an easy and exciting subject for female learners in STEM-related TVET pathways. This concern further adds to the relevance of counselling and guidance services for young people. It is indispensable when upper secondary subjects are sometimes detached or advanced from JHS subjects. Guidance and counselling services can encourage learners in JHS to take available courses and training that prepare them for these advanced subjects.

Considerable research on gender and mathematics shows that females struggle with mathematics. These studies have compared the quantitative performance of females and males to reach these conclusions (Li, 1999; Ng’ang’a et al., 2018; Sahin et al., 2017; Stoet & Geary, 2018; Wang & Degol, 2017). Quantitative research has shown that stereotypes, societal norms, structural disadvantages, cognitive performance, and mathematics anxiety mediate poor mathematics performance among young women. The usual rule of thumb is that poor performance in mathematics discourages young women from studying maths-intensive STEM courses (Means et al., 2016; Wang & Degol, 2013). Meanwhile, few researchers have engaged with young women to understand the qualitative reasons for their low performance in mathematics. However, interestingly, this finding was contrary to the common rational assumption in the empirical literature, which suggests that individuals with previously deficient performance in mathematics would often not choose and persist in maths-intensive STEM courses. Instead of the expected relationship between participants’ academic performance and STEM-related TVET choices (Eccles & Wang, 2016), there was a strong link between their interests, aspirations and STEM-related TVET choice. The reason for participants’ choice was based on value rather than performance. While the finding supported
the value component of the EVT model, it conflicted with one major part of the EVT model, which suggested a direct link between previous academic achievement and choice (Eccles, 2011a, 2011b).

This finding appeared to bring an alternative argument about the links between gender, mathematics performance and STEM choices. Thus, the value of a task, interest, expectancies of success and other mediating factors such as a child’s internalised self-efficacy beliefs in other aspects of STEM-related TVET pathways, such as practical engagements or the use of skills, can override the effects of poor mathematics performance on STEM choice and persistence (Bottia et al., 2015; Eccles & Wang, 2016). For instance, the majority of research by Eccles and her colleagues has found a correlation between mathematics ability and STEM education and career choice. However, an earlier study found that “performance expectancies predict subsequent math grades, whereas the perceived importance of mathematics predicts course enrolment intentions” (Meece et al., 1990, p. 68). It was significant support for two primary reasons. First, this important aspect of STEM education and career choice seems to have received little attention in the literature. Second, gender differential in mathematics performance appeared to be overemphasised compared to the value for task or expected success as determinants of choice.

Finally, the young women’s academic challenges in technical drawing and calculations appeared to be associated with the young women’s fixed internalised ideas of intelligence. Research explains that learners’ fixed mindsets about their academic performance in subjects such as mathematics can continuously affect their academic performance. It is, therefore, possible to explain that because participants had performed poorly on these two subjects in JHS or had no prior exposure to STEM-related TVET courses, it created the impression that these courses on STEM-related TVET courses were at an advanced level. Therefore, they felt they could not perform any better. Hence, classroom teaching and learning methods that improve participants’ mindsets about technical drawing and calculation can potentially transform their negative self-beliefs about these subjects and improve their subsequent abilities or performance (Hwang et al., 2019).

4.2.2.2 Hostile School Climate.

Participants reported that the lack of female STEM-related TVET teachers and verbal bullying from peers were the primary factors that made their school environments hostile. Participants explained specific needs, such as conversations about menstruation and personal hygiene, that, as female adolescents, they could not share with male teachers. Participants
suggested that despite male teachers’ supportive environment, it was hostile not to have female teachers. Evi said:

I am a female, and I cannot go to a male teacher’s house to learn. No. However, if I had a female teacher, I could go to the person’s house over the weekend or later in the day to learn. Furthermore, if I lack a subject, a female teacher could teach me after class. However, since we do not have female teachers, if we need the male teachers to help us after class unless we ask the boys to call the teachers to come to the class to assist us. It is not easy being in an environment with few girls, especially girls. If you need something, you need some advice (Evi).

Participants further explained their concern about female teachers not teaching STEM-related TVET courses. They shared that they believed that was because these courses are challenging to teach and because there are not enough females who study the courses in the first place. It appeared from their explanation that, as they were hoping to be employed in industry or become entrepreneurs, most female STEM-related TVET graduates preferred to work in industry or be self-employed. In the words of Evi:

At times, I do not understand why? Is it because the course is challenging that we are not getting female teachers? Because all our teachers are males. So, at times, it is because of the difficulty and the influence they have been getting behind that the course is challenging; that is why we are not getting female teachers. Moreover, it is sometimes good; maybe they work at the Electricity Company of Ghana (ECG) or in the office. That is how I think about it (Evi).

Surprisingly, respondents reported that verbal abuse from their peers, predominantly female peers on other courses that were not STEM-related, created a hostile school environment. In all the schools except DTI, It was common for participants to be verbally bullied by other young women, who saw their participation in STEM-related TVET courses as a counter-stereotypical decision. It was mostly young women studying traditional non-STEM-related TVET courses, notably fashion and catering, who were described as the perpetrators. These young women projected their misconceptions and negative narratives about young women’s participation in STEM-related TVET courses through verbal bullying. Participants, therefore, interpreted their experience with verbal bullying as an attack on their decision and a mission to make them feel irrelevant using derogatory descriptors such as dirty fitters. Awo reported:
They [female peers in fashion and catering] usually call us dirty fitters. Three sisters (female seniors) who completed the used to call me a dirty fitter… It was those catering students [with a sad tone]. When we came to the school, a sister told us we could never complete the course (Awo).

Aba said:

When I say I am taking an auto vehicle engineering programme, they do not believe it because they thought those courses were for masculine people. Sometimes they even say that flexible girls cannot take these courses because they are always rigid. So though always do that course to suit them.

We are flexible girls, and we can never study those courses. (Aba)

In the case of DTI, male counterparts in STEM-related courses verbally bullied participants. Yaa and Afa explained that the boys often told them they were not welcome in that class because they were girls. The boys would typically ask, ‘You are girls, so what do we want here?’ In other cases, they asked them to leave the class and join a female class such as fashion or catering. Aku remembered:

I would not engage with the boys in play and refuse whenever they tried to play with me. The way they treat me is terrible. They pushed me here and there and sometimes insulted me for no reason. However, now I am used to them. (Aku)

What was troubling about this finding was that although participants interpreted these experiences as abuse, which affected their well-being in school, they did not report cases to appropriate authorities. They tried to manage the incidences themselves using defence mechanisms they had developed over the years, such as explaining the reason for their decision or ignoring ridiculing comments. The participants could not report these concerns because there were no proper safeguarding protocols that governed peer-to-peer engagement and how to report abuse. What anecdotally confirmed this concern was that the counselling units in most schools were dysfunctional during the entire fieldwork period. The participants further confirmed that this had always been the case.

Although the current data cannot explain the lack of STEM-related TVET female teachers, this finding has been well documented in previous research (Ayonmike, 2014; Bleemer, 2016; Conner & Danielson, 2016; Ngugi, 2017). Although a lack of female or male teachers may not significantly impact male students, the lack of female STEM teachers at the secondary school level significantly impacts female students (Bleemer, 2016; Bottia et al., 2015; Conner & Danielson, 2016). For instance, Ayonmike (2014) argues that the lack of
female teachers in STEM and related subjects is one of the most concerning institutional factors that create a hostile environment for females in STEM-related TVET pathways in secondary schools. She further explained that inadequate STEM female teachers might impact the performance of females in subjects such as maths (Ayonmike, 2014). It is also a concern because the lack of female teachers in STEM further reinforces the negative perceptions of STEM education and careers, especially in cases where female teachers can serve as role models for female learners. It discourages female learners from progressing to STEM degrees (Conner & Danielson, 2016; Ngugi, 2017). Regardless of the teachers’ gender, one crucial recommendation is for schools to provide gender-responsive training to help make the classroom and school environment more welcoming and inclusive for female learners who are minorities in STEM-related TVET pathways.

Experiencing abuse is a primary reason that keeps young women out of school by creating a sense of isolation and loneliness (UNESCO, 2018). Some scholars have described bullying as a form of violence and aggressive behaviour, and the literature on violence in secondary schools in Ghana indicates a widespread problem (Asare-Danso, 2015; Lopez-Fogues, 2016; Mastercard Foundation, 2020; Ocansey & Gyimah, 2016). In a more specific form, Leaper and Brown (2014) argue that bullying is a form of sexism against young people and children, especially those in STEM who are considered outsiders or non-conformant, as described by the findings. Therefore, schools need to create a broad anti-bullying school policy that makes bullying in any form unacceptable and reportable and that provides guidance and counselling support (Leaper & Brown, 2014; Salmivalli et al., 2005)

4.2.2.3 Inadequate Equipment and Materials.

Participants reported inadequate equipment and material as another disabling lived experience. These young women explained that the inadequate teaching and learning tools, materials and equipment made practical lessons in schools complex and critically affected their expectancies of success. Figure 5.5 shows how students shared the same workshop with machines. Aba reported:

I did not feel happy about my workshop because sometimes, as the only girl, I could not join the boys in their social engagements, even when the conversation. So, the social aspect of communication is sometimes challenging but not the work. Sometimes I wish there were a girl in this version to feel happy about it. So that is the only problem I face when I go for attachment. (Aba)

Ama shared a common concern:
As we are in school with inadequate machines, we do not always have access to them. We also do not have access to these machines at home. When we vacate and go home without machines to practice, we forget what we have learned. It is difficult to remember the practical lessons. So that is the main challenge. (Ama)

**Figure 5.5:** Auto Mechanical Engineering Students Share Classroom with Equipment

Source: Author

The finding was consistent with the general TVET literature from Africa, which shows inadequate training equipment and resources are a significant problem. It is one of the main reasons TVET remains unattractive and misaligned with the industry (Darvas & Palmer, 2014). Achieving a positive outlook for STEM-related TVET courses among young women would require resourcing schools with equipment and materials for practical lessons (McGrath et al., 2019).

Based on the discussions in the previous section on the reflective affirmations, it was reported that the practical learning mode of STEM-related TVET courses was one of the reasons why young women chose these courses. They also believed that the practical skills they would acquire would lead to their success. Therefore, it is possible to explain participants’ frustration and disappointment when the inadequate machines in school led to insufficient practical lessons. These young women considered the situation disabling because they did not have the means to compensate for the inadequate practical lessons, mainly because accessing workshops with machines to practice through internships was challenging for these young women. The following section discusses challenges that hinder young women from accessing practice-based training in other workshops at home.
4.2.2.4 Work-Based Learning Struggles.

Participants’ final disabling lived experience was their struggle with work-based industrial attachments. Most participants had not experienced industrial attachment, and those whose courses required industrial attachment found accessing them problematic. Thus, these participants explained that their parents prevented them from pursuing industrial attachments because of sexual abuse concerns. Awo reported:

My dad said I was a young female, so he would not allow me to go for attachments. So, I was like, dad, no, I have not gone to attachment before, so if anything, I would like to go and catch up with my mates to learn more. I tried, and I still have not been able to go for attachments. (Awo)

Participants, like Shi, had to stop their attachment because of an abusive experience. Shi shared her experience:

When I went home, I used the period for attachment, but my master was irresponsible, so I stopped. I am not interested in the attachments; we are interested because it is the attachments where you can learn supplementary things. So, the boys can get attachments quickly, but the females struggle. (Shi)

Therefore, participants were left to rely on the limited practical lessons in school, expecting that they would have access to attachment opportunities after their upper secondary education or advance their skills at the tertiary level.

Participants reported that, despite these struggles, they considered industrial attachments a supplementary activity to the inadequacies in school practical lessons. Therefore, their participation in them would be beneficial. However, they were disadvantaged in taking attachment opportunities because of the hostile climate in workshops and parents’ negative perceptions about workshops because of male dominance. Research shows that employers in the formal sectors with the capacity and resources for employee engagement in training were not engaging with upper secondary TVET Institutes (Amegah, 2021). Hence, if young women cannot experience the world of work through work-based opportunities in the informal sector because of their gender, Ghana’s TVET system is losing its value in preparing young women for work. It is an even more significant concern when the practical opportunities in school are weak and patchy. Hence, participants’ aspirations and goals might be complicated by the current finding.
In terms of the dual experiences of young women studying STEM-related TVET courses, this research has shown that young women experience both enabling and disabling lived experiences. Figure 5.6 illustrates how positive and negative experiences combine to form a complete experience of being a STEM-related TVET learner. This means that, while there were efforts within the school environment to ensure that these young women could make the best out of their STEM-related TVET experience, they still had to navigate hurdles. Disabling experiences, such as hostile school environments, exhibited stereotypical elements that these young women experienced as STEM-related TVET learners. Other disabling experiences were specific to their unique challenges because of their courses. This calls for urgent measures to harness the enabling experiences and eliminate the disabling experiences.

**Figure 5.6: The Duality of Young Women’s Lived Experiences**

Source: Author

### 5.3 Theme 3: Developing Individual Agency

The theme of developing personal agency discusses how being a STEM-related TVET learner changed young women and how they grew and developed. As discussed earlier, the young women were a heterogeneous group at the beginning of their journey. A group of these young women decided to study STEM-related TVET courses right from the beginning of JHS, and others studied STEM-related TVET by chance or circumstance after
JHS. These young women had to deal with dual experiences and mediate enabling and disabling conditions in school. Associated with this was the need to develop themselves to navigate their STEM-related TVET education journey successfully, such as developing agentic characteristics to ensure that they made the best out of the STEM-related TVET choices. The individual agencies were the personal powers that young women employed to mediate disabling experiences to enhance their experiences as STEM-related TVET learners (Archer, 2014). Drawing on Archer's (2014) interpretation of personal powers as mechanisms to mediate constraints, these primary powers enabled participants to persist in their life projects. As Archer explains:

Agents possess properties and powers distinct from those in social forms.

Among them feature all those predicates, such as thinking, deliberating, believing, intending, and loving. (Archer, 2014, p. 2)

5.3.1 Contesting Stereotypes

Participants reported contesting stereotypes as a form of individual agency they adopted to challenge the stereotypes they faced in school or at home as female STEM-related TVET learners. Contesting stereotypes involved verbal practice where participants fearlessly opposed stereotypical ideas, actions, and theories at home and school using their STEM-related TVET knowledge and skills. A typical example of how participants contested stereotypes was noticeable in Awo. She used her knowledge about planes to contest the verbal bullying she experienced in school:

So, I told them [female peers studying non-STEM-related TVET courses] that it is wrong to call me a fitter as an educated young woman. It should rather be a mechanical engineer. So, they should stop calling me such a name because I am not a fitter; I am instead an auto mechanical engineer. Then I would tell them that if they were to work on the plane as an air hostess, I could also work on a plane. Then they asked which part of the plant I could operate. Then I explained to them that the aviation sector has many opportunities; primarily, the engines would be my expertise, mainly repairing faults. I am the one going to work on faults. In most planes, there is a black engine. When the engine has a fault, that black box detects all the faults with the plane. So, as an engineer, when you get there, you would be able to detect the problem faster, and I would get it done. Moreover, the plane can move on. So, I can work there, and we all can work there. (Awo)
Participants reported that they usually contested stereotypes in their communities or during attachments. The stereotypes participants contested in their communities, and the industry was not necessarily about their decision to study STEM-related TVET courses. It was scepticism about these young women’s ability to use technical skills as STEM-related TVET learners. Aku shared a story about how she confronted a stereotype in her community using her skills because no one believed her when she mentioned she was an electrical engineering student. So, she offered to help fix fans in her community mosque. She could not believe how all the men were surprised by the excellence of her skills:

Yes, I had to prove myself there … I went to the mosque to help them fix things. So, they gave me the fans to fix. I fixed all of them by myself, and I also fixed the bulbs and the lamps. Moreover, for the sockets, too, I did it. However, after I went on fixing the things at the mosque, the workers from my father’s companies told my father that they were surprised to see me doing it, and they did not know women could study STEM-related TVET courses and be good. Things like, ‘your daughter is good,’ and until now, my father and his friends are using my case to advise young women that they should not look down upon themselves because of how I am using my skills. (Aku)

Aba narrated that one of her masters asked her to remove a fuel pump at her place of attachment. Everyone was shocked and asked how a girl could remove a fuel pump. Although no one was expecting her to do it, she completed the task successfully:

So even those around us were like, how can I remove such a thing even the boys can never do without any muscles? Did anyone teach you? I said no, I did it myself. My master asked me to keep it up, and later on, he asked me to fix it. It became a headache for me. I decided to fix it the same way I removed it and said I could fix it. I fixed the pump back. There was no fault at all. (Aba)

Participants’ ability to contest these stereotypes revealed tensions that commonly arise when members of minority groups contest what they are supposed to do or what they aspire to achieve in cultural societies where structures constrain agents. TVET scholars in Africa have argued that most western theories fail to adequately capture these contestations, primarily because of the quantitative approaches to research (Unterhalter, 2003). Therefore, although the finding contributed to the self-concept component of the EVT model by mainly showing how participants build stronger positive self-schemata (Eccles, 2011b) through their
STEM-related TVET courses, it failed to capture how learners can contest social stereotypes. Also, one primary interpretation appeared to be that, rooted in these contestations, participants believed in their self-efficacy as eligible STEM-related TVET learners (Bandura, 2001; Fulcher, 2011). Thus, as participants believed in their self-efficacy, they showed that developing skills, knowledge, and competencies through STEM-related TVET courses was a potential capability of young women and a source of self-empowerment (Archer, 2014).

Lastly, it is possible to explain that these contestations of stereotypes were mechanisms participants developed to defend their subjective value for STEM-related TVET courses. It appeared, therefore, that these young women exhibited the utility value, interest-enjoyment value and attainment value of STEM-related TVET courses despite the relative cost (Kang, Keinonen, et al., 2019; Wigfield & Cambria, 2010). The significant showcase of knowledge and skillset mainly showed how STEM-related TVET courses fitted their individual future goals. Overall, it appeared that these young women mediated structures reproduced or perpetuated stereotypes and misconceptions about the participation of young women studying STEM-related TVET courses. Their mediation was to explain the relevance of these courses, provide adequate information about their courses and experiences, and use their skills to solve problems.

5.3.2 Seeking Academic Help

Participants appeared to use their agency to seek academic help with challenging courses. Participants struggled with technical drawing and calculations; hence, they needed to develop a strategy to minimise their failure and increase their expected chances of success. Help-seeking behaviour became a predicate that mediated identified learning struggles, and the ability of participants to seek help independently was interpreted as a subjective agency. The academic struggles of participants appeared as a confirmation of the deficit discourse about young women’s intellectual abilities in STEM and even worryingly appeared to have been internalised by participants; however, participants showed that their STEM-related academic struggles were surmountable. Their agentic attitudes, such as willingly seeking and receiving help, were tools to overcome academic struggles effectively. A typical example was noticed in the statement of Ayi:

Regarding practical lessons and calculations, everyone believes the boys know it better than the girls; they know everything. So, I also try my best to get them so that they can help me with the things that I do not know. (Ayi)
Further, Awo, in her narrative, explained that although she knew that the young men in her class exhibited more in-depth knowledge and skills than the young women, she made sure she was working harder and seeking help:

I also strive harder and make it. I would also make sure that I would do things, for example, seeking academic help that would supersede what the boys can do. (Awo)

While the first interpretation appeared to be that participants acknowledged their academic weaknesses, an in-depth interpretation showed that participants exhibited a keen sense of personal agency. Thus, instead of being discouraged by academic struggles, participants employed a self-regulated strategy similar to a locus of control to fulfil their expectations of success as STEM-related TVET learners. The finding showed that participants were determined to develop skills and knowledge vigorously for their courses and occupational goals. As noted in the narratives, the strategies employed by participants aligned with the eight common steps of help-seeking behaviour according to Nelson-Le Gall’s model:

1. determine whether there is a problem; 2. determine whether help is needed/wanted; 3. decide whether to seek help; 4. decide on the type of help (goal); 5. decide on whom to ask; 6. solicit help; 7. obtain help, and 8. process the help received. (Karabenick & Dembo, 2011)

Participants reported that the help they received was primarily in the form of additional theoretical explanations, especially with mathematics and sporadically during practical lessons. Participants' consistent use of ‘I’ is unique to this finding. It showed that participants subjectively took decisions and engaged learners in line with their internal locus of control. Aki stated:

When my teacher teaches and I do not get the understanding, I would go and ask him during his leisure time. (Aki)

Particularly for Ago, she sought academic help to recover from the extended Covid-19 school closures:

After school, I usually went to the class independently and revised my lessons, and I used that opportunity to ask teachers to help me. If only I had told them I had a problem, they willingly helped me learn. (Ago)

Helping-seeking behaviour has been identified as a cognitive and social self-regulation practice in achievement and goal orientation studies across psychology and education. Although help-seeking behaviour has been shown to reflect learners’ independent attitudes to skills and ability development, achievement goals and epistemological beliefs (Aleven et al.,
2003), it has not been described as a reflection of the personal agency of learners. Research shows that most learners would not seek help because of the negative cost of the stigma, admissions of defeat, self-threats and embarrassment associated with help-seeking. Therefore, if learners value a course and proactively seek help and gain that help for their potential success, they can be described as active agents of their circumstances (Archer, 2014).

Although the EVT model provides the tool to explore why learners might use agentic strategies, it fails to give the tools to explore the circumstances in which young people could evoke these strategies and the forms these strategies could take. For example, throughout this research, subjective task value and expectancies of success explain the achievement-related choices of participants. It posed a limitation to using the EVT model in atypical circumstances in cultural worlds (Holland et al., 1998). It was especially challenging for the analysis in Ghana, where children or young people need a subjective agency to thrive against socio-cultural structures and even personal weaknesses; this was particularly true in this research, where participants were academically weak but still chose STEM.

5.4 Theme 4: Developing Individual Identities

Developing individual identities revealed how participants developed specific identities due to their dual experiences. These identities were conceptualised as evolving developmental changes that appeared to be unique for a young woman studying a STEM-related TVET course. The conceptual framework of individual identity is based on Erick Erikson’s theorisation of identity as developing internal emancipation from a dominant group identity (Erikson, 1968). This is an identification process that these young women went through as they faced a crisis of being non-conformists. Based on these unique personal identifications of these young women as they mediated constraints, these women developed three identities, in the form of academic identity, character identity and vocational identity. The three identities were ongoing and developing selves that participants used to describe their understanding of their new selves as STEM-TVET learners and their ideal selves of potentially becoming engineers. The identities captured aligned with the ideas of who these participants were becoming and hoped to become. These identities in the form of self-understandings did not happen in a vacuum; the narratives showed that participants were intentionally altering themselves as STEM-related TVET learners.

5.4.1 Academic Identity

Participants described an academic identity of being responsible learners, which was in stark contrast to their self-descriptions as irresponsible when they were non-STEM-related TVET learners in JHS. By being responsible, these young women meant taking personal
responsibility to ensure their success as STEM-related TVET learners. Most young women believed that JHS did not expect them to be responsible, which meant they did not have any significant need for success. As STEM-related TVET learners, they were responsible for successfully transitioning into the labour market or a further education institution. Ago explained:

So, when I compare myself to inform one and when I came to Form 1 was aggressive, but when I compare myself now, I realise my aggressiveness is not relevant to education. Although fulfilling, the course is also problematic, so I need to be responsible. … now that I am about to complete school, I reflect on life after completion and learn to pass… I need to benefit from my three years in school. If I do not become responsible, I may leave home without good results. So, I am determined, and my aggressiveness should be for learning and practice. I am responsible for that decision. (Ago)

Interestingly, these young women explained that being responsible academic learners was a developmental change because of the progressive and challenging nature of STEM-related TVET courses and their expectations of success. ST2-EATI said:

Since I came to school, I have become more responsible; I have developed the desire to learn more because I have to succeed. I need to perform well and pass all my papers successfully. For example, I was quick-tempered, but I came to school and knew my course was challenging; I have been very responsible and obedient. I try as much as possible to ignore all provocations. I like my new behaviour, it made me more focused on my learning, and I am doing well. (Ata)

Shi described her experience:

Yes, I have noticed changes. Because the engineering course is challenging, I am now always learning. Because if you do not learn, the course becomes more difficult. So, I decided to be responsible and learn every time. When I was in Form 1, I was new to the entire course, so I was not too serious with these calculations and drawings. However, when I went to Form 2, I noticed I was becoming studious and saw a gradual improvement. In Form 3, I am confident to say I am doing well. These subjects have become standard now. (Shi)

The academic identity of the participants was consistent with the self-schemata of the EVT model, as it appeared that participants had developed an academic identity that was an
alteration of themselves so that they could achieve their goals (Eccles, 2011a). This academic identity of being responsible for their studies was participants’ subjective perceptions of whom they were becoming or had become rather than how other social members perceived them (Erikson, 1968; Mclean & Syed, 2015). Therefore, what was significant was how participants interpreted this identity as ongoing internal and external mechanisms they had developed from navigating identities and their lived experiences as STEM-related TVET learners (Kim, 2018; Vignoles, 2011). Most important, their academic identity was a transformation of how they approached their academic work from an indolent approach to a responsible and diligent approach.

Furthermore, the finding supports research that suggests that learners who adopt a growth-oriented approach achieve self-transformation (Alexander & Cook, 1979). These young women used intentional self-regulation methods such as expending extra hours to learn and asking for help to develop this academic identity to be successful STEM-related TVET learners and skilled engineers (Gestsdottir & Lerner, 2008; Kaplan & Flum, 2009; Pfeifer & Berkman, 2018). Gestsdottir & Lerner (2008) argue that the transformational period of adolescence places adaptational demands on adolescents. How these young women reviewed their actions and identified the need to change themselves to meet current demands has been conceptualised as self-regulation, personal agencies and international conversations in the literature (Archer, 2014; Francis et al., 2003; Gestsdottir & Lerner, 2008). Gestsdottir and Lerner (2008, p. 203) define these sorts of “self-regulation as individual-level characteristics that link the individual and the context and constitute how children, adolescents and adults contribute to and shape their development.”

5.4.2 Character Identity

Character identity conceptualises how participants interpreted the transformation of their character as STEM-related TVET learners. Participants reported that they had developed a ‘new’ character from being fearful to courageous as they continued to experience STEM-related TVET courses over the years. For these young women, it was not only courageous that they were studying STEM-related TVET courses but more so, studying STEM-related also helped them refine their sense of being courageous. The central interpretation was that through STEM-related TVET practical experiences, these young women had overcome their fears. According to these young women, they had become courageous. They overcame their fears through practical lessons associated with fire, hammering, electricity, climbing and digging. What was particularly interesting about participants’ character identity was their dissociation of courage from muscles. Although courage was commonly associated with
muscles or masculinity, these young women described their courage identity as a character of determination. It was also a symbol of their audacity to conquer practical activities such as digging, climbing electric poles, and welding metals that society perceived to be an exclusive domain for men because they have muscles. Ata explained:

The programme is not only about muscles. The young women who did not have macho [muscular strength or masculinity] but were not interested in the course did not pursue it. Equally, other young women like us are not macho but are pursuing the course. So, skills are not about muscles, and courage is not about muscles. For me, courageousness is about how I have developed the determination to study that course and not in the sense of being masculine or aggressive. (Ata)

Participants further explained that developing courage made them rethink their decision and stereotypical perceptions about STEM-related TVET courses. Aba said:

When I first came to the school, I said that I would change from the auto course to fashion, but later on, I learned that that course was even simple and did not need muscles. I told myself that all I needed was to be courageous and determined about this course and succeed. So, I can say that the development of courage in the course made me know that my course is better than other courses. I had to learn to be courageous throughout the course, and every year I got more courageous, and the stereotypes did not discourage me again. (Aba)

Aku reported:

So, the changes in myself are that I have become more courageous. The negative comments are coming more, my friends are trying to make me feel that I cannot do anything, and I am also thinking about myself. I am encouraging myself to be more courageous and confident so that nobody can hurt me. (Aku)

Concerning character identity, the finding was also consistent with the self-schemata of the EVT model, as it seemed participants had developed a character identity relevant to achieving their young people’s achievement-related choices (Eccles, 2011a). These young women altered an old character incongruent with their ideal identity as engineers. Therefore, there was a need for the participants to subjectively define what the problem was with their old character and how becoming courageous was important as a STEM-related TVET
learner. These participants’ understanding of courage differed from the social identity of courage as representative of masculinity (Mclean & Syed, 2015).

The finding has shown that these young women developed courage not to fit in with the social design of STEM as masculine but to create a congruence of their STEM identity as young, female STEM-related TVET learners. Therefore, there was no identity threat for these young women because they did not need to alter themselves to fit into the normative domain of STEM identity (van Veelen et al., 2019). For these young women, the gendered account of STEM education and work as masculine is unrealistic. Therefore, they redefined courage and dissociated it from masculinity to prevent any identity threat and the potential oversight of other salient connections between courage and other aspects of their education, such as performance. The findings confirm that when young women’s STEM identity is based on their STEM capabilities or efficacy, gender identity threat loses its salience (van Veelen et al., 2019). It is, therefore, essential to avoid the categorisation of STEM as masculine to ensure that these young women can identify themselves as courageous without any identity threat.

5.4.3 Vocational Identity

The participants reported that one aspect of their self-development that had changed was their vocational identity. The second-and third-year learners indicated a new vocational identity as skilled young women. Before they started their courses, the young women did not identify as skilled, but they now identified as skilled engineers. Afi, whose father and principal encouraged her to study architectural drawing, explained that she had developed her decision to study STEM-related TVET courses. Using comparative analysis, she showed that it made an enormous difference and brought meaning to her decision:

I do not regret coming here. Because now, I have skills that grammar school students do not have. Now I know the skills and training I am being put through are relevant to my future. Because I have my skills, I can even take a grammar school student and train for income. (Afi)

Aki, the only girl among 90 boys in the building and construction course, narrated how her skills were her identity because they gave her the same status as the boys in class. After all, she did the same practice engagements as the boys. In her words:

When I came here, I did not know how to do anything, but for now, I know I have skills I can use. I do not feel I am different from when I started the course because I did not know anything about building construction when I came here, but now I have an idea. It makes me feel good. (Aki)
Participants further explained that being skilled had convincingly demystified the perception that STEM-related TVET courses were only for males. The general interpretation was that skilled young women had become additional examples to show that anybody, especially young women, regardless of their academic strength and social background, could pursue STEM-related TVET courses. Ala said:

When I came to school, Form 3 mishandled my trunk, so eventually, I had to repair my trunk by myself, and that made the girls know I had skills. Sometimes, when people damage trunks, I repair them. When we come to the department, I sometimes produce coal pots [locally produced aluminium cooking stove that holds hot charcoal] and door hinges. I began to believe that I had also obtained skills. When they talk about mechanical engineers, I can also own up. Though I may not know everything, at least I know about crafting. Currently, I can manage a drilling machine, and I am always the one drilling for my department despite being the only girl on the course, to the extent that I have to supervise drilling activities for boys. (Ala)

These young women interpreted their vocational identity as skilled engineers with a sense of pride and confidence. Although all young women had a sense of pride and confidence, which was strongly associated with their developed skills, it appeared to be robust among young women who had not been convinced about their decision to study STEM-related TVET courses. Ama, who did not want to study software engineering but later joined the course, described her pride and confidence in her skills:

As a technical learner, I am proud of my skills. I am coming out with the knowledge and skills to solve real-life problems, but if I had gone to a senior high school, I would have no skills to use. However, I now know that after I complete technical school, I can have the skills to design software or start designing and developing. I feel good about using my skills, and I am confident. First, there was a problem with our fan, and a technical student graduate in my community from an NVTI came to check on a faulty fan. He suggested the fan was damaged and unrepairable. So, I told myself I could try, and it started working after trials. So, when that happened, I became excited, and my parents were excited. Because if a graduate certified in electrical engineering cannot fix the problem, but I can do it even though I have not completed school, then it means I have a future in this career ... I see myself as a capable person. (Ama)
Although it was evident that the second-and third-year students were more confident about their abilities and proud of how they could use their skills, it was fairly different for the first years. The difference was that, unlike the second-and third-year students who were confident about the skills they had gained, the first years had not gained any technical skills yet; however, they described their confidence in the belief of gaining skills by their third year. Afi said:

I know I can do it. I expect to be skilled in it, and I want to have more experience in engineering. At least I should do more practical lessons by my third year. When I worked with the Chinese men in my village, I even told them that I wanted to be a chief engineer in the future. I love it. I want to know it, teach others about it, and know it deeply. (Afi)

Ako related her expectations:

Our teacher has shown us how to prevent accidents and use safety materials like safety boots, helmets, gloves, and goggles. Our teachers taught us how to boot computers. However, I am confident that I can perfect the necessary practical lessons: I can do it with my technical skills. (Ako)

These narratives further highlighted the centrality of practical lessons to the developing selves of these young women. Young women used their success in either practical lessons or in applying their skills to solve real-life problems to measure the skills or skills to be gained. The experience of practical lessons or the expectation of experiencing practical lessons was linked to the notion of ‘I feel proud,’ which was the common phrase young women used to express their confidence and pride in their vocational identity. In Ayi’s words:

In Form 1, it was not easy at all. It was not easy for me because I was not knowledgeable about electricals. However, in the second term of the second year, when we returned from Covid-19, I learned that installation was a more challenging course than principles. It is full of calculations. (Ayi)

Aku said:

I am confident in the practical lessons because I can do things independently, like fixing fans, sockets, and switches. I can do something about them all by myself. I felt confident in my abilities whenever I fixed these faults, and I knew that if I did it, there would not be any problem with it. (Aku)

The vocational identity of these young women was grounded in their ideal career as engineers and other related careers instead of an abstracted conceptualisation of scientist
In terms of how young women interpreted their vocational identity, the current study shows a deviation from the standard narrative of how females studying students had to identify themselves as scientists (Seyranian et al., 2018; Steinke, 2017). The idea of STEM learners becoming or identifying as scientists have primarily been the case because of the narrow, limited research focus on STEM identity. This does not mean that STEM-related TVET learners did not identify as scientists or nerds-genius (Starr, 2018). Instead, their vocational identity was associated with the practical application of their knowledge and competencies to solve problems.

Also, the vocational identity of these participants was consistent with self-schemata. It appeared that these young women had developed a vocational identity that was their subjective interpretation of what they believed was an ideal job rather than what society prescribed as an ideal job for STEM learners. There is a concern about the paucity of research concerning the identity formation of young African women studying STEM in upper secondary education Technical Institutes. Researchers overemphasise STEM identity formation in post-secondary education (Schwartz, 2005; Su & Rounds, 2015). Schwartz (2005, p. 299) suggests:

> Including middle and high school adolescents from most identity research allows for examining only the tail end of Erikson’s identity stage. Early and middle adolescence, during which identity development is first envisioned and undertaken, may provide valuable information about the antecedents to and correlates of successful identity development.

### 5.5 Theme 5: Expected Progression Pathways

The expected future progression of these young women emerged in the research as a core aspect of the final critical experience of being a STEM-related TVET learner. After studying STEM-related TVET courses at the upper secondary level, all participants were confident that they expected to transition and progress. While the expectation of transitioning and the delight about potential opportunities were universal, the options differed across participants, depending on economic background and future goal orientation. The theme consisted of three sub-themes: (a) further education, (b) employment, and (c) entrepreneurship—these sub-themes related to participants’ occupational orientations.

#### 5.5.2 Educational pathway

Participants reported that their primary progression aspiration was further education. There were broadly three options that appeared through the analysis: progression to local technical universities, progression to foreign technical universities, and progression to
informal advanced Technical Institutes. First, technical universities were the most preferred progression option among these young women. Most participants explained that technical universities were the preferred education option to gain advanced skills, complete their identities, and realise their aspirations as skilled engineers.

Sometimes, I tell myself that I want to become a better engineer, not an ordinary engineer. So, I want to go higher and higher. I want to go to a technical university, and I am determined. (Evi)

Aki, a building construction learner, said she wanted to continue at the technical university. According to her, Koforidua technical university was a preferred choice. She excellently captured her expectations by stating:

I want to go to university, and I am preparing for it. I prefer to move to TTU [Takoradi Technical University] in Ghana. I have a school father [male senior] in TTU, so I asked him about the programs. He completed it last year, and he performed well. So, I am in touch with him to prepare. So, I have asked him about their courses. (Aki)

However, further education at a technical university appeared to be the most preferred option in all cases. A group of young women were torn between the decision to transfer to a regular university to read a degree that might not be offered in technical universities in Ghana but regular. For example, Awo aspired to become an aviation engineer, and although she was specific about transitioning into further education, she expressed confusion about which route to take:

I was telling myself that I wanted to be an aviation engineer in the future. I have been told that KNUST [Kwame Nkrumah University of Science and Technology] offers a programme in aviation engineering. However, I am being told to go to a technical university first because if I want to move from the Technical Institutes to KNUST, I will find it extremely hard. The reason was that they are doing elective maths and here we are not offered elective maths. However, when I go to the technical university, I will study engineering maths to get more familiar with that before starting elective maths. So, after my technical university, I can go there further. They always say that the University of Ghana also offers aviation engineering. I asked my senior sister, and she researched it. (Awo)

Other young women aimed to transition into further education, but not in Ghana, because they wanted to explore international education to advance their skills. It was also
noticeable that the young women who wanted to advance to university in Ghana sometimes aspired to travel abroad to further their education if that option was available. The perceived advanced and modern infrastructure in foreign universities was one of the main reasons why participants preferred foreign universities. For instance, Evi, who was confident about transitioning into higher education, stated she wanted to travel abroad for studies for the following reasons:

I want to travel abroad; if I get the chance, I get the chance to go there, I will go. The learning over days is different from what we are learning over here. I was listening to our teachers. Even last week, one of our teachers talked to us about learning abroad and in Ghana. (Evi)

Ama, a second-year software engineering technology learner, had the same aspiration, but, in her case, she was not considering any local university:

I want to study software engineering. I do not want a technical university in Ghana because of the machines they have outside there; I think we do not have those machines in Ghana. So that is why I prefer pursuing my degree in Russia over Ghana. Although I do not know any university in Russia, I have discussed it with my sister, who was in Russia and had just finished her medical degree there. She is back home, so I asked her if there were technical universities in Russia. (Ama)

Likewise, Awo, although she had chosen to go to Takoradi Technical University, was also considering studying abroad:

So, where would I want to be one day in the USA? My uncle will help me further my education there to become an engineer, and after that, I want to work there. (Awo)

Moreover, other participants, like Ayi, wanted to advance their skills through other further education institutions. Ayi, an IT student, said she wanted to advance her knowledge through two means. She wanted to take an advanced course in the informal sector before progressing into further formal education: ‘As for me, my brother told me that when I complete school, he will help me go to IBB at Cape Coast. IBB is a computer school for programming, software, and networking (Ayi). The primary interpretation by these young women is that they wanted to advance their studies to achieve their dreams as engineers. This could happen through either a higher education institution or an informal certified TVET accreditation Institute like IBB. A different interpretation was that these young women experienced difficulties in practical lessons due to inadequate tools, materials and equipment
that made them believe they needed further education in Ghana or abroad to acquire advanced skills.

Further analysis showed that young women from low-income families were not choosing to progress to further education. Such participants did not choose further education, even when it was their preferred progression option. These cases presented how economic factors, even if removed for pre-tertiary education, might not completely solve the problem of interest. Aba, who is from a single-parent family, captured the uncertainties of realising her further education aspiration:

However, sometimes I wish that before we complete school should get a scholarship. For instance, my mother is the family; there is only one taking care of my sister and me, so if I get the scholarship, my mum’s burden will be lightened because the sponsors will take care of me, my feed and my books and everything. Because by taking care of me, my mum’s burden will be less. (Aba)

A potential interpretation was that young women like Aba, even if they passed their examination, are unlikely to progress to higher education despite that route being their preferred option. Therefore, it was common for young women to make employment an alternate option and make further education a long-term aspiration. The finding on educational aspirations shows that these young women were conscious and persistent with their aspirations. These young women were already thinking about the various educational options available, with financial circumstances and perceptions about the accessibility of routes being critical determinants of educational aspiration. Participants’ determination to progress to higher education showed high aspiration among young women to stay in STEM-related TVET pathways. The evidence is contrary to the leaky pipeline argument, which suggests that young own leave STEM education as they progress. These young women’s narratives brought into account a potential explanation that needs further investigation. That is, girls and women might not actually leave STEM; instead, there are multiple educational pathways that young women may consider when making their education progression decisions, and these pathways might not conform to the traditional expectations. Therefore, there might not be a ‘leaky pipeline’ in STEM as proposed by some researchers (see, among others, Elias & Jones, 2006; van der Vleuten et al., 2018; Wong, 2012).

5.5.2 Entrepreneurial pathway

Entrepreneurial aspiration appeared to concern aspirations that involved participants’ desire to use their skills to set up businesses in their trade domain. Entrepreneurship for these
young women was an opportunity to earn an income after completing their upper secondary education without further education. It was rare for young women without sufficient financial support or low-income families to consider progressing to a technical university immediately after completion. Their immediate option was to find the means to set up an enterprise. Ata, who came from a low-income family of eight, was sure she would not immediately transition to a technical university and was already planning to set up a garage. Still, before that, she needed to work to raise funds:

I have plans of building the garaging anywhere or where my auntie lives. I may be able to save enough, and with enough skills, I can build my garage.

(Ata)

Another excellent example was the case of Ami:

I will open my shop so that what I come to learn will be helpful. If not, there will be no meaning for me coming to school. I will just become like those who went to grammar schools and are at home without jobs to do. (Ami)

It appeared that these young women interpreted entrepreneurship as an option that allowed them to set up their workshops and become masters of their trade. For them, this was the ultimate value of the skills they gained from technical education.

Although Aki aspired to study building construction technology at a technical university, her short-term progression was to start an informal enterprise to raise funds for further education:

After school, I mean when I complete my technical course, I will find some work to do so that when my results come, then get a small amount, and I will ask my elder brother and sisters to help me. (Aki)

The entrepreneurial aspirations of these young women show that for learners to achieve their aspirations, they are steered towards these aspirations based on educational climate, economic and social background, access to relevant information, and personal values. (Deosaran & Augustine, 1997). For example, Dalton et al. (2016) found that poverty exacerbated the aspiration failure of young women. Thus, these achievement-related choices are susceptible to failure because young people from low-income backgrounds may turn towards lower aspirations and endeavours relative to the best outcomes they had intended to achieve. For instance, a study in Tanzania showed that young women faced certain gendered constraints when entering the labour force. Often, young women without social capital receive information within the labour force. Disturbingly young women had resorted to unfavourable agency often through solicited sex before securing a position, and for such
reasons, many women turned to self-employment to avoid sexual harassment (DeJaeghere, 2018).

5.5.3 Employment pathway

Other participants explained that they preferred employment because it was a secure means of saving money for further education or building a workshop as an entrepreneur. For example, Ayi, who wanted to study at IBB, also chose employment as an immediate option if there were no funds for higher education. She said:

They have said that if you are a lady in a boy’s course [STEM-related TVET] and you go out for a job, you have the opportunity and a bit of knowledge of the course, it is easy for you to get a job to do. So, maybe when I have completed here and go out and have the knowledge and you can prove it, as a young woman, you get advantages. You just go to the job, and they will study you, and if you were able to move and work hard, you could get permanent employment. (Ayi)

Similarly, Aba, who also wanted to further her education but was from a single-parent household, shared that her most preferred progression option was to find employment at a mining company in her community:

There is a mining company in my village. I have studied the company very closely, and they have no girls. It sounds like maybe, after completion, I can go there and start my career there. I can go there and request a work opportunity, and hopefully, they will select me. (Aba)

In other cases, employment was not an alternative to higher education. It was the only progression route. Young women who chose employment as their only progression route explained that they did not believe in their academic competence for further education or had the aspiration to join a trade that recognised their upper secondary certification. For instance, Ago explained that she did not believe she would be successful in higher education because of her challenge with mathematics:

Yes, as I have said earlier, I have difficulties in calculations, so if I find it difficult here, I cannot do that at the university, which is an advanced level. I consider it irrelevant to continue my education. I see that I can become somebody in the future. I can become a relevant person with the job I want to become, especially in the military. After completing technical education and passing my technical exams, I should be able to join the military. (Ago)
The findings added to previous findings by showing multiple progression routes for STEM learners to apply their practical and theoretical knowledge. The interpretation was that even if young women remained on STEM-related TVET career and education pathways, they had done so purely based on their determination and aspirations. In terms of employment aspiration, the finding was consistent with the argument of Petray et al. (2019), who states:

The ‘pipeline’ metaphor is part of the problem: it implies a particular pathway into engineering shaped by narrow curricular concepts of STEM education. Instead, we suggest that engineering disciplines consider recruiting from a “deep pool”—one that recognises and values the dispositions generated through engagement with creative and critical curricula. (p. 10)

5.6 Summary

Throughout the study, there appeared to be several practical and contextual reasons why participants may want to progress into different pathways and two of these reasons stood out. The first is the labour market demands in these young women’s communities, and the second is the predisposition of young women’s communities. Thus, for young women who were from communities that had certain favourable labour market conditions they were certain of continuing into higher education to obtain the higher certification that could allow them to enter those labour markets. This was particularly the case for young women who reported living in mining communities where the existing mining company had a community quota that targeted young women in engineering. In this case these young women did not have the intentions to enter the labour market as some of these colleagues who did not have community arrangements.

For young women who came from communities that were predisposed to certain labour market structures could consider entering labour market after their training. For instance, young women who were from towns or cities that had existing formal and informal labour market demand for their skills without further higher education were noticed to consider seeking opportunities as employees of such organisations or setting up their own workshops. This was especially the case for young women from urban communities and the reason could be that young women could anticipate their relevance in such circumstances. These intentional consideration show that young women’s career decision making were not in a vacuum, instead they were considering the viable conditions that could make their aspirations achievable. It appears that the relevance of guidance and counselling that provide young women with the right labour market expectation cannot be underestimated. Like the initial
concerns, the insufficient guidance and counselling services in schools and out of school can make young women create a delusion between their aspirations and labour market viability.
Chapter 6. Reflections and Conclusion

6.1 Reflections on Research Findings

The current research project explored the lived experiences of young women studying STEM-related TVET courses at upper secondary Technical Institutes in Ghana’s Central and Northern regions. Although a significant body of literature exists on young women’s participation in STEM, little is known about the lived experiences of young women studying STEM-related TVET courses in upper secondary TVET institutions. The current chapter provides an analysis of two core objectives of this thesis. First, it reviews the study's findings by addressing the research questions and reflections on the core findings that contribute to the existing knowledge about young women’s participation in STEM. The chapter delves into the research findings' theoretical, practical, and policy implications. It further explores the researchers’ reflections on conducting the research given the Covid-19 pandemic and the challenges, limitations, and gains encountered while carrying out school-based research during a pandemic.

The current research investigates the complexities of studying STEM-related TVET courses in Technical Institutes as a young woman in Ghana and how this lived experience shapes identities and aspirations. As such, the core four research questions this research sought to answer were:

1. How do young women pursuing STEM-TVET courses at ISCED Level 3 in Ghana decide to pursue STEM-TVET courses?
2. How do young women pursuing STEM-TVET courses at ISCED Level 3 in Ghana make sense of their experiences as STEM-TVET students?
3. How do young women pursuing STEM-TVET courses at ISCED Level 3 in Ghana define the effect of pursuing STEM-TVET on their identities?
4. How do young women pursuing STEM-TVET courses at ISCED Level 3 in Ghana consider their aspirations?

Second, the chapter discusses the contribution of the research to the field. It summarises the research, theoretical, policy and practice implications and future directions. The research summary involves an overview of the introductory chapters and the primary findings. The implications for theory, policy and practice discuss how the current research outcomes are relevant for change and how those changes can come about through the recommendations deduced from the research findings. Finally, there is a discussion on directions for future research, in which I provide steps for future research and identify areas that still need critical attention by researchers.
6.1.1 Research Question 1

Answers to RQ 1, ‘How do young women pursuing STEM-TVET courses at ISCED Level 3 in Ghana decide to pursue STEM-TVET courses?’ showed that at age 11, most of these young women were actively planning to study STEM-related TVET courses. They started considering STEM-related TVET courses as a concrete personal project (Archer, 2014) by the first year of JHS, i.e. between the ages of 10 and 11. The other group of young women did not make a STEM-related TVET choice at JHS; they chose STEM-related TVET courses either after JHS or after their first year in a Technical Institute. In the case of these young women, realising their aspirations involved navigating complex social and political structures impinging on their long-term occupational goals.

The complexities of choosing STEM-related TVET courses were noticeable in the layers of validations, invalidations, influencers and underminers young women navigated. Despite the differences identified among these groups of young women, they were generally able to make a non-confirming decision. These young women reviewed the information available to them through their social networks at home, at school and in the community; this was especially the case when their fathers and other social actors provided validation through encouragement and support for their decision. Only certain mothers provided positive validation for the young women to study STEM-related TVET courses; most mothers did not validate their daughters’ decisions to study STEM-related TVET courses. Other social actors, such as teachers, brothers, sisters, and uncles, were also instrumental in this decision-making process, either as influencers or underminers.

6.1.2 Research Question 2

Investigation of RQ 2 ‘How do young women pursuing STEM-TVET courses at ISCED Level 3 in Ghana make sense of their experiences as STEM-TVET students?’ demonstrated a duality between how young women made sense of their lived experiences as students studying STEM-related TVET courses. Studying STEM-related TVET courses was an enabling experience, yet there were disabling experiences for young women studying STEM-related TVET courses. The duality of their experiences was shared among all the young women. For young women in TVET Institutes in the Central region, their male colleagues were critical allies in providing academic support. For young women in the Northern region, however, their male classmates were not their allies but their underminers. Although it is difficult to explain these differences from the data, they might be associated with the region’s cultural and historical predispositions against girls’ education. For example, Ghana’s Northern region is highly patriarchal and has a culture that undermines young
women’s education through cultural practices such as child marriage and female genital mutilation (Asare-Danso, 2015; DFID, 2005; Tuwor & Sossou, 2008). Despite the challenges, the young women displayed agency to achieve their aspirations. They were resilient and empowered by their enabling experiences rather than being derailed by the challenges they faced.

6.1.3 Research Question 3

Answers to RQ 3, ‘How do young women pursuing STEM-TVET courses at ISCED Level 3 in Ghana describe the effect of pursuing STEM-TVET on their identities?’ indicated that young women were actively developing three core identities. These identities are associated with using science to impact different fields practically. These identities can be classified as academic identity, character identity and vocational identity; all three were constructed self-identifications developed as these young women navigated their experiences as STEM-related TVET students. Thus, these self-identifications were not constructed in a vacuum; they were shaped by how the young women used agentic strategies to navigate the constraints they were experiencing. For most of these young women, who did not perceive themselves as high academic achievers, their ability to navigate STEM and transfer the theoretical knowledge to solve problems and contribute to development meant they had developed a new definition of academic abilities. They were no longer academically weak; they had become academically capable learners who had shown their capabilities in theory and practice.

In terms of character identity, this was a form of self-identification that these young women associated with specific characteristics they were developing because of their lived experiences as STEM-related TVET students. The specific character identity was associated with courageousness and seriousness, characteristics not generally associated with girls, women, and femininity. These young women unanimously identified courageousness as feminine. The young women, consciously or unconsciously, were rewriting the narratives and traditions about gendered character identities. In simple terms, character formation is not associated with gender. However, it is shaped by navigating structures and social norms by social agents who dare to challenge and transform the status quo.

Finally, these young women, especially the third-year students in their final year of training, had fully embraced their identity as engineers. Most of these young women had developed stronger self-esteem about their vocation as capable engineers who gained the needed theoretical and practical knowledge and skills to work in their preferred engineering fields. Through an analysis of the answers to RQ 3, it became understood that these young
women were diligently working as agents to navigate personal, cultural, political, and structural constraints that could interfere with their projects of becoming engineers.

6.1.4 Research Question 4

Findings from RQ 4, ‘How do young women pursuing STEM-TVET courses at ISCED Level 3 in Ghana think about their aspirations?’ revealed that young women were reasonable and pragmatic thinkers. They had intentionally reviewed the transition options and had practically considered the internal and external resources, such as academic abilities, financial resources, and educational policies. What was interesting about the pragmatic decisions made by these young women was their ability to be realistic, resilient, and future-focused simultaneously. The findings redefined the local and international discourse about young women in TVET in two ways. Young women aspire, and those aspirations are enduring yet at the same time amendable. Thus, although internal and external constraints challenged these young women’s aspirations, they did not lose sight of them; instead, they prepared to accept short-term progression routes that prepared them to achieve their long-term personal projects. The findings showed the calculating and agentic capacity of these young women. For instance, an informal job to save money for the university was an excellent example.

However, in reality, that is not always the case. The world of work has changed, and it keeps changing, which means that the use of STEM knowledge and skills has also changed; therefore, there are non-traditional fields that require STEM knowledge and skills. Hence, the STEM pathway could be seen as a route with multiple exit channels, enabling young women to use their STEM-related knowledge and skills in careers they value and where they expect success. Not always society determines what young women should perceive as valuable and successful, as shown by young women in this research. Thus, young women as agents can pursue education and career pathways that reflect their values, which might not always align with gendered social roles.

6.2 Contributions to the Field

The current research makes five original primary contributions to the current understanding of the participation of young women in STEM education and careers. Primarily, the research explored how young women navigate their decision to study STEM-related TVET courses. The findings contribute to the current literature by showing that young women consciously make achievement-related choices and decision-making processes, but not in a vacuum. Thus, young women are active participants in what they choose as their education and career aspirations, and the process is not purely determined by social, cultural,
and economic structures. Young women consciously seek to access multiple sources of information and examples of possibilities for their aspiration to make that final decision (Archer, 2009).

In addition, the findings challenge the narrative about the participation of girls and women in education. In contrast to the presumed narrative that young women in patriarchal societies are unlikely to have support from male social actors, the research shows otherwise. Male social actors, such as fathers, supported young women’s STEM decisions more than female social actors, such as mothers. Fathers as social actors in this study have shown that they could be strong allies of the movement to increase young women in STEM-related TVET programmes. Particularly, fathers can become the primary source of encouragement for young women in making a non-conforming choice against all odds. Mothers, on the one hand, might consciously or unconsciously perpetuate the gender divide in STEM-related TVET pathways by encouraging their daughters to choose TVET courses prescribed for females based on social roles.

Second, the current research explored the lived experiences of young women studying STEM-related TVET courses in four Technical Institutes in different regions of Ghana. The findings contribute to the existing literature by suggesting that the experience of being a STEM-related TVET learner in Ghana is primarily about dual-lived experiences of enablement and constraints, one that begins a period of self-development and a transformation to the identification of young women. Thus, the current study shows that young women constructed themselves positively, moving away from their beliefs as academically low-performing young women to capable young women. They developed internal and external resources and identities associated with responsibility; they developed a positive view of self and gained confidence in their beliefs of becoming engineers in the future. These young women developed strategies, such as help-seeking behaviour, to navigate the disabling constraints to become successful STEM-related TVET learners.

Third, the findings contribute to the existing body of knowledge by explaining how TVET policy discourses and their theoretical underpinning contribute to the under-participation of young women in STEM-related TVET courses. The findings on TVET policy discourse have shown that policymakers and actors in Ghana have not been able to adequately define the problem of the under-participation of young women in STEM-related TVET courses in Ghana. First, TVET policies do not discuss the problem at all. Second, even if there is a discussion about the circumstantial problem, the language used is limited to a gendered perspective, human capital or human rights approach that uses a deficit discourse to
discuss young women’s participation. The findings shed light on why TVET policies are deficient in their understanding of the problem and why they have failed to address it. The main reason was that in most instances, these life projects are not motivated by economic gains or to help nations achieve human rights and gender parity scores; instead, they relate to young women’s life aspirations for their freedom and fulfilment.

Finally, the current research contributes to the existing body of knowledge by providing a detailed account of how the expectancy-value theory of achievement-related choice can be used to study and trace the decision-making process involved in educational choice. The prevailing literature, mainly that using the expectancy-value theory of achievement-related choice to study young women’s participation in STEM education, has neither studied nor found the effect of planning of education and career choice among young people (Eccles & Wang, 2016; Matusovich et al., 2010; Rosenzweig et al., 2019). Also, there is a paucity of research about the impact of school level or age on education and career choice among young people. One can explain that the absence of such findings among STEM researchers using the expectancy-value model could show a failure of the model to explore how young people plan their achievement-related choices.

Most STEM research has focused primarily on STEM aspirations at distinct levels of education other than lower secondary education. For example, there is substantial research on STEM aspirations in primary school (Chambers et al., 2018; Kashefpakdel et al., 2019; Sheldrake & Mujtaba, 2020). There is significant research on STEM aspiration at the post-lower secondary education level, high school and higher education levels, such as college and university (Edwin et al., 2019; Olsson & Martiny, 2018; Tzu-Ling, 2019). The focus on STEM aspiration in primary school is based on sizable research that suggests that gender stereotypes in STEM began in primary school (Mann et al., 2017; Percy & Amegah, 2021). Then, research on STEM aspirations at higher school levels is based on the human and social capital assumptions that young people around these ages have had exposure to the labour market. Thus, young people can transition into the labour market for economic development through school-mediated career education and employer engagement activities (Kashefpakdel et al., 2017; Sahin et al., 2017).

6.3 Theoretical Implications

The current research explored how young women decided to study STEM-related TVET courses and how their lived experiences as STEM-related TVET learners fit with the posited expectancy value of the achievement-related choice model in the extant literature (Hood et al., 2012; Wang et al., 2013; Wigfield & Eccles, 2000). The theoretical implications
explore how the current research's primary findings align, contribute, or refine our understanding of the expectancy-value model by Eccles and her colleagues in the Ghanaian context and how that can guide future research. The diagram of the expectancy-value model demonstrated in Figure 6.1 with areas marked orange demonstrates the areas of the comprehensive model that were researched or applicable in the Ghanaian context. The theoretical implications of the nine elements of the model marked are discussed to explore their theoretical implications and contribution to the field.

**Figure 6.1:** Ten Elements of the Expectancy-Value Model Applicable in the Current Context

Source: Author’s illustration of Eccles (2011b, p. 512)

### 6.3.1 Cultural Milieu

The current research found support for all three components of the cultural milieu element of the expectancy-value model. Gender roles, cultural stereotypes regarding STEM-related courses and occupations and family demographics such as parental income, parental employment status and educational status were significant to the study's findings (Eccles, 2011a; Eccles & Wang, 2016). Although it was difficult to measure which components significantly affected these young women’s choices, the analysis confirmed that young women immediately considered gender and cultural stereotypes. For instance, young women explicitly confirmed that gender roles and cultural stereotypes about STEM-related TVET pathways were issues they considered relevant to their decisions. The information received from influencers and underminers was about gender role restrictions and negative perceptions of girls' and women’s participation in STEM careers. This is the case in Ghana, and it can be similar to other contexts with strong social and cultural fibres that determine divided roles for men and women. Overall, it confirmed the relevance of conceptual behaviour in education.
and career choice; this research brings to bear how young women can make non-conforming education and occupational choices.

For Ghana, as an emerging economy with large disadvantaged economic families, it would have been expected that family demographics such as family income would be a decisive factor. However, in Ghana, given the FSHS policy, which has made TVET free, the burden on families was not the direct financial cost of young women accessing STEM-related TVET courses. The cost of education was the opportunity cost and other associated costs such as buying books, tools and general costs not covered by the free education policy. This finding requires further studies to understand how other educational costs might play a prominent role in young women’s education and occupational choice in countries that practice fee-free secondary education.

6.3.2 Socialisers’ Beliefs and Behaviours

The beliefs and behaviours of socialisers are one of the elements of the expectancy-value model that has been studied extensively in the field, and the current research provides supporting evidence for this. Young women in this study considered the perceptions of influential people in their lives. Most existing studies have used this element of the expectancy-value model to study how perceptions of socialisers, especially mothers, influence young women’s decision not to choose STEM-related TVET courses (Neuenschwander et al., 2007; Rozek et al., 2017; Šimunović et al., 2018). The current research shows that the model is equally applicable to studying how the perception and behaviours of other socialisers, such as fathers, uncles, and community members, influence young women’s decisions to study STEM-related TVET courses.

6.3.3 Child’s Perceptions About Social and Cultural Factors

The current research contributes to the expectancy-value model by providing a robust qualitative understanding of how young women’s evaluations of personal, social, and cultural factors, such as gender roles, influenced STEM-related TVET choices. The existing expectancy-value literature has not dealt extensively with this model element. Therefore, the current research shows that young women are analysing and evaluating the social and cultural factors that impinge on their life projects to study STEM and work in STEM fields. As discussed in Chapter 4, young women solicited information and perceptions about their decisions. The data suggest that afterwards, they engaged in a subjective evaluation of their decision. For instance, the encouragement received from reinforcers were resources that consolidated the validations these young women received from their fathers.
6.3.4 Child’s Goals and General Self-Schemata

The child’s goals and general self-schemata is an element of the expectancy-value model that has received some level of attention from researchers in the field (Eccles, 2009; Loh, 2019). The current research provides evidence that young women have goals and a sense of identification, which evolve according to their aspirations. It further shows that the model has the potential to help researchers understand how aspirations evolve among young women who choose STEM-related TVET courses. This is because the existing literature that has used the model to study goals is limited, and the studies fail to study how young women construct aspirations and how these aspirations develop in different contexts. For instance, the findings on identities in Chapter 4 show that young women’s aspirations to become engineers shaped them positively. Generally, these young women developed positive identities in academic work, character, and vocation, and for them studying STEM-related, TVET tended to transform their identification process.

6.3.5 Child’s Interpretation of Experience

The current findings support that these young women did not simply experience learning STEM-related TVET courses but also interpreted their experience. Although the expectancy-value model fails to explain how to measure young people's interpretations, the phenomenological method used in the current study allowed the generation of data concerning how young women made sense of their lived experiences. These personal interpretations framed what were enablers and constraints to young women in the context of studying STEM-related TVET courses. These personal and collective interpretations explained how and why young women choose to retain their STEM-related courses without dropping out.

The relevance of a child’s interpretation of experience to the achievement-related choice of young people is the ability of young people to actively review and evaluate their lived experiences according to their expectations, values, and goals. These young women’s ability to interpret how they can be agents of change through determination and resilience to impinge social and political structures undermine their capabilities. Theoretically, it would be significant for researchers to comparatively study how young women studying STEM-related TVET courses interpret their experience in different contexts. It will be essential to understand the tools they use in these interpretation processes and how these play a role in their decision to retain their STEM-related TVET choice.
6.3.5 Child’s Affective Reactions and Memories

The child’s affective reactions and memories were the elements of the model that I determined were intricately linked to how young women interpreted their experiences. There was evidence that young people considered memories and affective reactions in their achievement-related choices. It is important to note that this element was identified as an ongoing process rather than an instant occurrence in the decision-making process of these young women. Thus, there was an apparent connection between the interpretation of experience, memories and the affections associated with the experiences. For instance, young women associated an intense sense of fulfilment with their overall decision, but there was a divided affection between constraint experiences and enabling experiences. Most young women had vivid and joyful memories of their first day in school, their first practical experiences using tools, materials and machines, and their success at practical work.

However, there were no strong memory or positive affections associated with constraints, and young people discussed experiences that constrained their agency, such as the lack of machines in workshops, as challenges that they developed new agencies to navigate. Although this element was relevant in the current study and linked to critical findings in other studies, the element has not received attention in the literature. The element needs further exploration to understand how young women develop specific affections toward their experiences and how they shape long-term and short-term achievement-related goals.

6.3.6 Subjective Task Value

The subjective task value of the expectancy-value model predicts that young people are highly likely to enrol on courses that have excellent task value for their projects (Eccles, 2007). The current research supported this position by showing that young women decided to study STEM-related TVET courses based on their assessment of the utility value, interest and enjoyment value, attainment value and relative cost of STEM-related TVET courses. These core subjective values were the most significant influencers of young women’s decisions, particularly the interest and enjoyment values. In contrast, young women did not report any form of the relative cost associated with studying STEM-related TVET courses. These young women considered stereotypes, negative perceptions and challenges associated with being a young woman studying STEM-related TVET courses as forms of relative costs. However, these relative costs were not interpreted as unfavourable but considered opportunities to develop and grow. Thus, these young women approached the relative-cost associated challenges with a growth mindset. This model has not extensively developed an
understanding of the sub-element of relative cost. The current findings contributed to the theoretical understanding of the subjective task value by highlighting how young people, as agents, have the subjective power to define what is valuable to them.

Furthermore, the findings support the enjoyment and utility value of the subjective task value. Despite the challenges, young women showed that prominence in enjoyment and interest were more likely to determine their task value for STEM-related TVET courses than their attainment value. The findings need to review the relevance of attainment and performance in determining educational and vocational choices. Also, it is an opportunity for researchers in this field to reconsider the different forms and measures of attainment. For instance, for most of these young women, their source of attainment value was associated mainly with practical performance rather than attainment in theoretical knowledge assessed through writing exams. Their pride was in their skills and the practical use of these skills. Practical use of skills is becoming a theoretical implication for the expectancy-value model because of the focus on TVET, where practical skills are relevant.

6.3.7 Expectations of Success

The current research supported the expectations of the success domain of the expectancy-value model, which predicts that individuals are highly likely to choose courses in which they are confident of their mastery and likelihood of success. The findings supported the subjectivity of education and occupational choices among young women. Thus, young women’s personal beliefs of success and mastery of their chosen STEM-related TVET course and occupation were independent of social perceptions of their abilities and intellectual skills. Support for the expectations of success was directly linked to young women’s short- and long-term goals. Particularly the findings support Eccles' (2007) argument that many available alternatives may never be considered by young people who might not know about them. However, young people are highly likely to choose education and occupational options where they know they have a high sense of self-efficacy.

6.3.8 Stable Child Characteristics and Previous Achievement-Related Experience

The stable child characteristics and the previous achievement-related experience were the two primary domains of the expectancy-value model that the current research did not support. Apart from the gender of young women, which was relevant to understanding how young women’s experiences, other elements of the stable child characteristics, such as the attitude of children and siblings and birth order, did not appear to be contextually relevant in the current research. The young women studied did not narrate any consideration of their aptitude or the aptitude of their siblings in making their STEM-related choices. Even in the
case of gender, young women did not consciously consider their gender when making their educational choice. Gender appeared to be a factor for consideration at the social level, especially at the point where some social actors questioned young women’s decisions based on gendered roles. The current implication for the theory does not suggest that the stable child characteristics domain is not relevant, as it might be relevant in other contexts and under different research approaches. For instance, if the research had focused on young women who did not choose to study STEM-related TVET courses, that could have changed the outcome of the research to make gender a relevant stable characteristic.

The current research did not support the previous achievement-related experience domain of the expectancy-value model. Although Eccles and her colleagues depict previous achievement-related experience in the expectancy-value model displayed in Figure 6.1 as having a direct influence on achievement-related choice, this was not the case for most young women. One of the key challenges with this domain is that Eccles and her colleagues do not expand the domain with examples. Therefore, for the current research, the immediate achievement-related research experience was young women’s academic performance in science courses. However, as discussed in Chapter 4, young women’s academic performance did not determine their final choice. In most cases, young women did not consider their academic challenges in science or maths. They instead considered their interest and expectation of success and value for STEM-related TVET courses.

Overall, the expectancy-value model of achievement-related choice was applied to the research and aided in understanding how and why these young women studied STEM-related TVET courses. Although the decision-making process is not linear or similar in the cases of all young women, all the ten crucial domains of the expectancy-value model were relevant for young women’s STEM-related TVET choices.

6.4 Implications for Policy and Practice

The findings of the current research have significant implications for policy and intervention. These implications are for four key actors: policy actors, school counsellors, social actors, and young women. The first significant implication of the current research is for education policymakers who design and implement TVET policies that target the participation of young women in STEM in TVET pathways. The second set of implications applies to social actors, including family members, teachers, and community stakeholders. The third implications are for school counsellors who support young people's education and career decisions. The final implications are for young women in Ghana, who are the central focus of this thesis.
6.4.1 Implications for Policymakers

The study has pointed out major discourses that currently set limitations to the design and implementation of policies to increase the participation of young women in STEM-related TVET courses. The over-dependence on human capital discourse, gender discourse and human right discourse are of concern. Although these perspectives themselves are not problems, the problem lies in how these concepts define a limited approach to solving the under-under-participation of young women in STEM-related TVET courses. TVET policy designers and implementers can adopt a broader discourse about the under-participation of young women in STEM-related TVET courses, such as the critical-capability perspective, and apply it to TVET policy. This can shift the transformation agenda for educating young women in STEM-related TVET courses from achieving gender parity to an encompassing lens that accommodates the values and flourishing of young women.

More so the findings point to the need for policymaker to concentrate on the design and delivery of school guidance and counselling. The emphasis is on the overwhelming need for quality and equitable and accessible provision of guidance and guidance counselling in Ghanaian public schools. The inadequate provision of guidance and counselling services has been well documented in Ghana’s guidance and counselling literature (Aryeetey et al., 2013; Namale & Awabil, 2018; Ocansey & Gyimah, 2016). Amegah (2021) found a similar trend while investigating employer engagement in upper secondary TVET Institutes in Ghana. The primary implication is for the Ministry of Education and the Ghana Education Service to provide primary and secondary schools across Ghana with professional guidance and counselling officers with offices and resources situated in schools to ensure the quality and adequate provision of guidance and counselling services. The reason for this recommendation and the emphasis on professional counsellors is that there is evidence to suggest that adequate guidance and counselling services for young women in schools could create an enabling environment for them to exercise their agency. Through guidance and counselling services, young women could find adequate information to inform their internal conversations better to study STEM-related TVET courses, especially in a cultural world like Ghana, where social norms and culture pre-determine gendered roles and careers.

Policymakers should ensure the school counsellors who have the opportunity to guide young women in deciding their education and occupations have resources to contribute to improving the outcomes of young women’s participation in STEM-related TVET courses. School counsellors can provide adequate and unbiased information about all pathways, courses and careers open to young women. This research has shown instances of
unprofessional delivery of school guidance and counselling. There should be quality processes to implement policies that train experts to deliver biased perceptions about young women’s participation in STEM-related TVET courses. Policymakers should know that school guidance and counselling officers have a unique role in making young women make and pursue these non-conformist choices. School counsellors have complementary and supplementary roles in supporting young women’s education and vocational choices. For instance, young women who show interest in STEM-related TVET subjects in class but do not have knowledge about courses, careers, and outcomes of STEM-related TVET fields can be recommended for counselling and guidance. Information about STEM-related fields and work-based experiences, such as industry visits to observe STEM-related TVET industries, can inspire young women to choose STEM-related TVET courses.

Finally, there should be a national intervention for the recruitment and retention of females in STEM and TVET courses in Ghana’s upper secondary TVET sectors. Policy makers in their effort to increase the participation of young women in STEM-related TVET should consider the recruitment and retention of female teachers as one of the primary factors for the flourishing of young women who choose STEM-related courses. As discussed by the participants of this research, the absence of female teachers in STEM-related TVET courses, was a constraint that hampered their consistent engagement in the classroom. For most of these young women, beyond teaching, there were critical needs that male teachers did not have the knowledge and experience to provide them with the relevant support. According to these young women, female teachers in STEM-related TVET would become role models and their presence in or out of classroom provided a level of confidence and security as they navigate their life projects in an environment that has majority of its population being makes. This is one of the primary recommendations that the Ministry of Education and CTVET can add to the inclusive TVET agenda.

6.4.2 Implication for Social Actors

The second implication of the findings suggests that pre-technical drawing, science, and maths teachers in JHS can lead young women in identifying their interest and aptitude in STEM-related TVET courses. These teachers can then direct such young women onto the STEM-TVET and educational pathways. Particularly for teachers who teach these STEM-related courses at JHS, their critical role as first-hand witnesses of what young women exhibit as interests and abilities in STEM-TVET subjects are crucial to this identifying and recommendation process. Unlike school counsellors, teachers have first-hand knowledge of young women’s engagement through teaching and non-teaching hours.
Teachers and parents as social actors should consciously and intentionally support and encourage young women who show interest in pre-technical drawing, science, and maths, regardless of their actual academic or intellectual performance. Thus, teachers should use various means of assessment, such as practical lessons in school, as a necessary form of assessing interests and abilities of young women in STEM-related TVET programmes. For instance, maths and science teachers should not undermine young women who underperform in science, maths, and pre-technical theoretical exams but can use their practical knowledge and skills. Instead, it is an opportunity for teachers to capitalise on young women’s knowledge, interests, and abilities in practice to encourage them to project a positive sense of self-efficacy in their theoretical performance.

These young women have shown that they can improve their academic performance with more specialised support for their theoretical performance. The STEM-related TVET course instructors at these Technical Institutes have shown how this extra commitment and encouragement can motivate young women to improve their studies. The relevance here is that young women may not always exhibit standardised ideas of intelligence or characteristics a scientist or engineer should have. Instead, looking out for those obscure yet relevant characteristics, such as interest in practical work or self-confidence in the ideas of studying STEM-related TVET courses or working in a STEM-related TVET field, could be a beginning to get young women to choose and retain STEM-related TVET courses and occupations.

6.4.3 Implication for Young Women

The final implication of the findings is that young women conceptualise themselves as empowered citizens with the agency to set an example for other young women. These young women’s self-confidence, self-efficacy, determination, agency, and self-regulation show how young women can be capable citizens with the agency of choice. Therefore, a suitable environment and support can enable them to achieve their freedoms. These young women and others who continue to make non-conformist choices are setting the standards and clearing a path for more young women to join STEM-related TVET fields. The current finding has added to a growing body of literature on capability, highlighting the agency of girls and women. These young women are excellent examples of how the voices and agency of girls can define their freedom to choose what they value as social agents regardless of the challenges they have to navigate.
6.5 Future Research Directions

The current research investigated the phenomenon of choosing and studying STEM-related TVET courses for young women in Ghana. The approaches used throughout the study, both conceptually and methodologically, allowed a deeper exploration of the life world of these 26 young women. It allowed the explication of facets of choosing a STEM-related TVET course. The context of experiencing life as young women studying STEM-related TVET courses and aspiring to be engineers had not previously been explored. However, as with all research, there are two directions for future studies that have evolved from the current research. Future research can focus on a comparative investigation into the decision-making processes and lived experience of young women in STEM in general academic pathways and those in STEM in TVET pathways. This current study has provided an understanding of the missing puzzle in the current gender divide in STEM: the narratives of young women in STEM-related TVET courses in a developing context. Therefore, future research can use this foundational yet revealing research to build further research projects that comparatively study the decision-making processes among young women in these different pathways. The aim of such research should be to provide an understanding of the similarities and differences between the choices of young women in these two pathways. Such an understanding is needed to provide tailored support for young women in both pathways and inform policymakers and educators on navigating support and guidance.

Another area that future research can focus on is investigating how the knowledge constructed by these young women can be used to inform policy and design an intervention that affords more young women the autonomy to choose STEM-related TVET courses. Significant outcomes of the findings provide a clear understanding of the nuances of making a non-conformist choice. However, there is still a need to use the research's understanding and policy and practice implications to address the issues. One of the more practical steps adopted from the research is to design a guidance and counselling intervention focusing explicitly on STEM and TVET. Such an intervention aims to provide young people, especially young women, with the necessary information and exposure, such as employer engagement activities, to know about different pathways to STEM education, training, and occupations. As one of the first researchers to investigate this topic in Ghana, I am designing an intervention as the next step after my PhD.

Transition 360 is a three-pronged transition intervention designed to increase the participation of young women in STEM-related TVET courses. The intervention aims to help young women, especially those from underprivileged groups, navigate their education and
career choices in STEM-related TVET fields. Prong 1: *Inspiring STEM-TVET* is an interactive virtual or in-person school-based event designed to provide JHS learners with unbiased information about science, technology, engineering, and mathematics (STEM) education and careers in technical and vocational education and training (TVET). Prong 2: *Inspiring the Future (Ghana)* is an interactive career talk event where young people meet industry speakers and counsellors in person or virtually. Prong 3: *Inspiring Experiential Learning* is a system that creates functional interactions between learners and the world of work through work-based opportunities during long vacations. Transition 360 is a natural outgrowth of previous research projects for my PhD. The theory of change of Transition 360 presupposes that guiding young people with unbiased information about the values of education, training, and work, complemented with opportunities to engage with the world of work, can lead young people to make informed decisions.

### 6.6 Reflection on Personal and Research Development

Research experience during the pandemic provided an unusual opportunity to develop as an early-career researcher. At the personal level, I developed skills in two domains. First, I developed my critical thinking skills. Under this domain, I acquired and expanded my ability to think critically about emergency scenarios that could interrupt or disrupt data collection. The critical thinking processes included planning multiple backup strategies that would specifically meet the needs of the research context and, at the same time, meet the overall aims of the research. The unique circumstances of the Covid-19 pandemic offered the opportunity to be intellectually creative while adopting theoretical and methodological techniques that could be malleable to change.

Second, I developed my skills in research governance and organisation. These skills were needed and developed to help me acquire the specialised knowledge required to lead the design and delivery of medium-scale qualitative research during the pandemic. I became a disciplined leader during fieldwork, managing my research grant, participants, and my life during the pandemic. The organisational and leadership skills I developed were noticeable through my decision to ensure I was not putting myself in danger, nor was I putting my participants in danger. For instance, despite the absence of direct scrutiny by schools during the interview sessions, as a leader, I ensured that all Covid-19 pandemic protocols were observed by myself and all participants. Overall, my PhD experience, especially my fieldwork, allowed me to develop a strategic and thoughtful personality as a research leader who thinks purposefully to meet the needs of uncertainties while protecting her well-being and that of her participants.
As a researcher, I developed my research skills in three primary domains. First, I developed knowledge and intellectual ability regarding the research field and the methods used. For this domain, I acquired and expanded my specific knowledge about the participation of girls and women in STEM education and careers. It is important to note that, although I could not have possibly covered the entire literature in this area, I have developed an in-depth understanding of the various conceptualisations of the under-participation of young women in STEM throughout the literature. I have had the opportunity to rethink what conceptualisations could be valuable in addressing the problem. Also, this research taught me how to use IPA and CDA as qualitative research methods. These are new forms of methodological knowledge and skills I did not know prior to this PhD, but I have become vested in these research methods. I now know the philosophical underpinnings and research questions these research methods can help answer.

Second, I developed the critical domain of developing compelling interviews. During the research, and especially conducting fieldwork with the uncertainty caused by the COVID-19 pandemic, I had to develop more constructive and effective ways to engage with these young women, who were also facing the uncertainties of the pandemic. For instance, I learned the skills to conduct interviews open-mindedly with the flexibility to amend the interview questions and customise the process to suit each participant's needs. This flexibility to adapt the interview process on the field was necessary because I could not conduct a pilot prior to the fieldwork as schools were closed due to the pandemic. Navigating the interviews without any pilot meant I had to develop additional time management and communication skills, as these were needed to sustain the ongoing flexibility employed throughout the fieldwork.

The final skill domain was my academic writing skills. I have changed and developed my writing skills from a less coherent style to a more coherent style of writing. I had to develop an innovative writing strategy that involved consistency from the sentence level to the paragraph level. Although these skills are still developing, I now have a solid writing foundation that has enabled me to disseminate the research outcome through conferences and peer-reviewed journal articles. The ability to write up my findings for other researchers, policymakers, laypersons, and practitioners to broaden my research's impact is a critical component of which advanced academic writing skills are crucial.

These personal and research developments led to a decision to reflect on the progress and challenges experienced throughout the PhD process; this revealed two changes that could have been implemented subject to time and funding. The first addition would have been
interviewing young men who were studying STEM-related TVET courses and had female colleagues. The second would have been to interview the parents of the young women I studied. Upon reflection, interviewing these two categories of people would have provided additional context about the social and cultural milieu surrounding the participation of young women in STEM-related TVET courses. Male colleagues and parents, especially fathers, appeared to be strong allies of young women in STEM-related TVET courses.

The assumption is that the narratives from these male learners and fathers would have helped provide an understanding of two core issues. The first core issue is why it was relevant to support young women in STEM-related TVET courses; the second was to understand from their perspective why young women were not choosing STEM-related TVET courses. The absence of this understanding does not take away the essence of the current research, which is to understand the lived experiences of young women studying STEM-related TVET courses. A future follow-up study can further investigate these core issues to understand the two issues raised.

6.7 Conclusion

The current research has explored the lived experiences of young women studying STEM-related TVET courses in Technical Institutes in Ghana through tracing their decision-making processes and aspirations. The current research findings suggest that young women are active agents of their education and occupational choices. In making these decisions, they consciously solicit information about different available options to help the comparative evaluation of these options before making their final decisions. In this process, they navigate validators and invalidators and underminers and influencers who play a vital role in providing information and creating perceptions about young women’s choices. The study shows that regardless of enablers and constraints navigated, the experiences of these young women become a self-identification and transformation process that leads to personal growth and development. The young women begin to construct themselves positively due to being STEM-related TVET learners. They move away from the perception of being weak learners who are not fit to study STEM-related TVET courses to being intelligent young women who are capable of studying STEM-related TVET courses. They develop internal resources associated with responsibility and determination, enabling them to work towards their life projects of becoming engineers. In other circumstances, as they idealise being engineers, these young women fought against the social stereotypes that made STEM-related TVET courses young men’s preserve.
The implication is the ability of these young women to contest negative stereotypes that aim to undermine and derail their effort to achieve their life projects of becoming engineers. Over time, these young women appeared to resolve any fears, especially by the final year. They develop confidence and believe in their competencies as STEM-related TVET learners, which diminishes any negative incongruent beliefs about themselves and their abilities. They finally choose to continue their STEM-related TVET aspirations through multiple rational routes, of which some might not be traditional pathways. However, importantly, the pathways identified by these young women were options valued and believed would help them self-actualise.

The significance of this research is three folds. First, it has explicated the dual experiences of being a young woman studying STEM-related TVET courses at Technical Institutes in Ghana. The study draws attention to the unique challenges young women face in their efforts to study STEM-related TVET courses in a socially structured context that divides education and career along cultural norms, such as gender roles. Second, the study has demonstrated that the enablers that inspire young women to remain in their chosen STEM-related TVET pathway can create a better understating of what factors education policymakers can harness to improve young women’s participation in STEM-related TVET courses. Finally, the current research methodology, which combined two different qualitative research methods within the interpretive phenomenological and critical realist paradigms, has shown how mixed method qualitative research help researchers investigate requestions through a nuanced lens adequately.

Overall, the core findings of the lived experiences of these young women demonstrate how they used their agency and developed capabilities through the utilities of enjoyment and the costs of challenges to continue the pursuit of their life projects. Their resilience challenges the dominant misconception about the participation of young women in STEM-related TVET courses and the dominant discourses that have defined STEM-related TVET fields as male-dominated fields. The reality might be that more young men choose STEM-related TVET courses and transition into STEM-related TVET industries than young women, but that cannot be the sustaining reality for all young women. These young women have shown that there are enablers that can transform the reality of many young women who can study STEM-related TVET. The understanding that young women are capable social agents with capabilities and values for their flourishing is key to the needed transformation.
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Appendices

Appendix A: Sample of Transcript Analysis Using the Sonocent Audio Notetaker

Researchers: Tell me about yourself!

P2Z-A5I: I am an electrical engineering student at Awarozi Technical Institute. I'm in my 3rd year.

Researchers: What did you do at school when you were at the age of 9 or so? When I got to SHS level, I told myself that I want to become an electrical engineer in the future. So I told my dad that I want to be an electrical engineer. Although my mum did not want me to do that, she was supportive for me to go and do the course design. But I was not interested in that. I wanted to be an engineer because if I do the electrical engineer, it will be beneficial to me. Those that are in the secondary schools think, it is not bad to be the secondary school. It is also good to be learning the things they are learning in secondary schools. But I felt that I just want to be an electrical engineer that's why I came to Awarozi Technical Institute to do that course. Although it was not easy for me, but I knew I could do it.

Researchers: Why was it not easy for you?

P2Z-A5I: It was not easy for me, there were a whole lot of challenges when I came. And when I completed SHS it was difficult for my parents to admit me here. While I was free SHS, although it was free SHS, it was not easy. They went to poorer individuals. They all needed me to go to school but was not enough financial support in the house. They were trying to tell me to go out there and earn a trade. But I resisted. I told them I will go to school. As far as there is free SHS, I know I can do it. So I can quite remember my mum, she made a lot of sacrifices for me because of the schooling. I bought my things and I was brought here. So it was not easy for me at all and even
Appendix B: Sample of Superordinate Theme and Sub-theme Map Using MindView Software
Appendix C: Sample of Yes or No Table to Access Superordinate Themes from Recurrent Themes

<table>
<thead>
<tr>
<th>Young Woman</th>
<th>Social and policy Milieu</th>
<th>Processes to choosing STEM-related TVET</th>
<th>Young women’s constructed identities</th>
<th>Lived experience as exceptions to the norm</th>
<th>Inspired to skill-up</th>
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Appendix D: Sample of Colour Coding of Transcript

- **Social and policy milieu**
  > Influential persons
  > "It was only my mum who helped me because my dad doesn’t do work that provides payments (income)." 3
  > "I shared my views with only one of my sisters." 3
  > "The influence was from home. And the first is my mum. And my mum her problem was with the course. And as for my brother too he said the school facilities at [school] is not good." 4
  > "He (brother) said that after technical school you can do your personal work. Like you have some skills in your hands to do, he also attended the same school (Anwara)." 15
  > "My brother influences me about technical school." 15
  > "It was our school counsellor who informed me about the changing of programme or school." 22

- **Influential knowledge and experience**
  > "Here I benefited a lot. That the JHS. Because here I am boarding student. I can now learn over here than JHS." 7
  > "I’ve seen my friends most of them even if when they complete school when it comes to financial, the visual arts and if their parents don’t get the money to make them move forward. They were doing those designs and not most people who come to demand. It is only a few of them. And that one will not give them enough money. But I realise that as for the agriculture even if I don’t continue, as I choose to do animal husbandry and crops. I can raise my farm in poultry or vegetable farming. The agriculture will help me a lot than the visual arts." 5

- **Influential perceptions**
  > "most of the people who talk about technical school, they Said technical schools they do practical a lot than the college (school)." 14

- **Personal interest and aspirations**
  > I thought because I had the talent that was why I chose it 4

- **Academic performance**

- **To choose or not to choose**
  > Lower secondary as critical school year
  > Identifying interest and capabilities
  > "Myself I chose to do visual arts because I know how to draw." 2

```
"Yes, I’ve always been interested in visual arts." 2

- Matching interest and capabilities with schools, courses, and careers aspiration and job prospect
  > "Because I know how to draw human being and I like drawing a lot. So it was in my mind that I will choose to do visual arts in senior high school." 1
  > "I compared the agriculture and the visual arts, and I said to myself as for the agriculture, if I complete without any work like if I don’t get any work from government, I can choose to do my homework. I mean private work." 3
  > "But I realise that as for the agriculture even if I don’t continue, as I choose to do animal husbandry and crops. I can raise my farm in poultry or vegetable farming. The agriculture will help me a lot than the visual arts." 6

- School selection process
  > "And I agree with them, and they changed my course. So I was doing agriculture in Anwara, but they don’t do practical lessons. They only do theory, so I told my parents, and they know more about Anwara Technical Institute agriculture program." 1
  > "I was then placed to Anwara technical Institute. And here to the agriculture is good and they do practical, and they also added theory to it." 1

- Accept not to accept
  > "I made all the decisions by myself." 2

- Young women’s construction of identities
  > Responsibility
  > "I’ve changed. As for the visual arts I did not used to learn frequently. Sometimes I said it is not difficult. I will just draw and sometimes even you add some small theory to it. So I did not used to learn too much. But as for the agriculture I used to learn a lot." 11

  > Skills as competencies and abilities
  > Skills as courage/proud

- Used experience as exceptions
  > Agency as Aspiration, confronting stereotypes, help seeking, learning, and abilities
  > "I want to work hard in learning to achieve or to bring out the best results." 14
```
Because I’m a boarder and I learn. 19

- Support and encouragement
- Self-efficacy/confidence
- Challenges/difficulties

No attachment I will only study from the books when I go home. But when schools reopens then I can do the practical. 19 is this about the financial problem. If I get it I will do it but I don’t get it. 19

- Valuable experiences

“sometimes the Cape Coast technical university they take us there (the girls who do TVET so I went there they encouraged us, that it is not difficult for a woman to engage herself in TVET so they encouraged us to continue” 11 12

- Negative or positive evaluations

So I feel comfortable over here. And I choose to stay here.

“It is good I like it”? 2

“I think I’ve seen that I have benefited a lot from it. Because in this course we used to do [agriculture]” 3

I think it is good and that is what it will help. 20

- Inspired to skill up

- Career prospects

I want to become an agricultural manager” 13

- Higher education

“If there is financial support if my parents are able to take me forward 13

- Changing status quo
Appendix E: Sample of Letter to Head Teachers/Principals

The Headteacher  
Enyan Abasa Technical Institute  
P.O. BOX 4  
Enyan Abasa, Central Region.

Dear Sir/Madam,

Introduction to Young Women in STEM-Related TVET Research

Despite the increasing call for diversity and inclusion in science, technology, engineering, and mathematics (STEM), education and technical and vocational education and training (TVET), young women’s participation in STEM-related TVET programmes in Ghana remains low. Hence, the design to conduct qualitative research to investigate young women’s lived experiences as STEM-related TVET students in Ghana. Also, it is important to address this critical topic. The investigation is born out of the belief that young women’s participation in STEM-TVET can enhance their capabilities. Evidence suggests that the under-representation of young women results from personal and societal challenges and is an issue of concern. Therefore, the current study explores personal attributes and socio-cultural factors that contribute to young women’s decisions to pursue STEM education in TVET in GES TVET senior high schools in Ghana. Additionally, the study further proposes exploring how young women decide to pursue STEM-TVET. In Ghana, the Central region has the least male to female enrolment ratio (7:3). Therefore, I selected the Central region as an evidence case of this problem to learn the most.

The research proposes randomly selecting at least five female students pursuing STEM-related TVET at different academic levels from the institute for interviews. Based on the proposed theory and perspectives from existing literature, the interviews sessions will probe topics including the social milieu, personal attributes, decision-making, identity, experiences, and aspirations. The proposed tentative months for the interviews are January, February, and March 2021 for all the three schools. The interviews will take place in the schools’ premises after school hours in a quiet and comfortable space where young women can talk freely and confidentially for about one to two hours. All data collected during this research will be kept confidential and only used for research purposes. The information will be safely stored for about ten years. At the end of the research, I hope to identify mechanisms that can help design policies and systems to attract more young women into STEM-TVET education in Ghana. As part of my efforts to contribute to the advancement of all young women and men in the selected schools, I hope to receive permission and support to organise membership and motivational talks to inspire young women.

Attached to this letter is a standard informed consent form to be signed and returned as additional proof of accountability and credibility. In addition to the formal approval by the Director of GES, Prof. Kwasi Opoku Amanfela, these pieces of information and other attached documentation, it would be an honour to receive approval to conduct the research. I hope to receive your kind consideration to begin the research process soon. I am willing to provide and meet any further requirements.

Yours sincerely,

Aloso Amegah
University of Cambridge  
Faculty of Education  
Tel: +233 303523454  
Email: ag2017@cam.ac.uk/a.amegah@gmail.com
Appendix F: Sample of Photography, Filming and Recording Consent

Consent Form for Photography/Filming/Recording
Faculty of Education University of Cambridge 184 Hills Rd, Cambridge CB2 8PQ

UNIVERSITY OF CAMBRIDGE
Faculty of Education
January - July 2021

This form is to consent to the researcher, Alice Amegah, a PhD student at the University of Cambridge, UK, to use tape recordings to generate transcripts for the current research. The transcripts may be used in print and digital media formats, including the dissertation, print publications and websites.

Please indicate ‘Yes’ to the following to give your consent regarding tape recording the interview session with you.

I consent to the use of tape recordings of the session for your PhD dissertation and subsequent publications:

I have read and understood the conditions and consent to the use of the tape recordings:

Print Name

Signature

Date

The current research is committed to processing information under the General Data Protection Regulation (GDPR). The personal data collected on this form will be held securely and will only be used for research purposes.

Yours Sincerely,

Alice Amegah (PhD candidate/researcher)
University of Cambridge
Faculty of Education
Thank you.
Appendix G: Sample of Informed Consent Form for Participants

Informed Consent Form for Field Study.

Topic: Making a choice out of the norm: the lifeworld of young women pursuing STEM-TVET in senior high technical schools in Ghana.

I, the undersigned, confirm that (please tick the box as appropriate):

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>I have read and understood the information about the project as provided in the information sheet dated</td>
</tr>
<tr>
<td>2.</td>
<td>I have been given the opportunity to ask questions about the project and my participation.</td>
</tr>
<tr>
<td>3.</td>
<td>I voluntarily agree to participate in the project.</td>
</tr>
<tr>
<td>4.</td>
<td>I understand that I can withdraw at any time without giving reasons and that I will not be penalised for withdrawing, nor will I be questioned on why I have withdrawn.</td>
</tr>
<tr>
<td>5.</td>
<td>The procedures regarding confidentiality have been clearly explained (e.g. use of names, pseudonyms, anonymisation of data) to me.</td>
</tr>
<tr>
<td>6.</td>
<td>If applicable, separate terms of consent for interviews, audio, video or other forms of data collection have been explained and provided to me.</td>
</tr>
<tr>
<td>7.</td>
<td>The use of the data in research publications, altering and archiving has been explained to me in line with the review and approval of the University of Cambridge’s Central University Research Ethics Committee.</td>
</tr>
<tr>
<td>8.</td>
<td>I understand that other researchers will have access to this data only if they agree to preserve the confidentiality of the data and if they agree to the terms I have specified in this form.</td>
</tr>
<tr>
<td>9.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>I, along with the Researcher, agree to sign and date this informed consent form.</td>
</tr>
</tbody>
</table>

Participant/Authority:

<table>
<thead>
<tr>
<th>Name of Participant</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
</table>

Researcher:

<table>
<thead>
<tr>
<th>Name of Researcher</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
</table>
INTRODUCTORY LETTER

This is to introduce to you Ms. Alice Amegah, a PhD in Education candidate at the University of Cambridge, who is undertaking a research on females' participation in Science, Technology, Engineering, and Mathematics (STEM) Education and Technical and Vocational Education and Training (TVET).

The aim of this research is to understand the identities, experiences, and aspirations contributing to the decision of young women choice of STEM related TVET programmes in GES TVET Schools in Ghana.

Ms. Alice Amegah would visit GES TVET Schools in the Central Region for the proposed research from January, 2021 to April, 2021. The schools are Assam Technical Institute, Cape Coast Technical Institute and Egun–Abana Technical Institute.

By a copy of this letter, kindly let District Directors of Education concerned inform Heads of GES TVET Schools within your Region that approval has been given to Ms. Alice Amegah to proceed with her research work and that they should accord her the necessary courtesy and support.

Please, all protocols regarding the COVID-19 pandemic should be observed and adhered to strictly.

Thank you.

Yours faithfully,

Dr. Kwabena Bempah Tandoh
Deputy-Director General (QAD)
FOR DIRECTOR GENERAL

cc: The Director-General, GES, Accra
The Deputy Director-General (MS), GES, Accra
The Director, Schools and Instruction, GES, Accra
Ms. Alice Amegah, Accra.
Ms. Alice Amegah
Accra.

RE: REQUEST FOR RESEARCH PERMISSION

In response to your letter dated 12th October, 2020 to the Director-General, Ghana Education Service, requesting permission to conduct a research on females’ participation in Science, Technology, Engineering and Mathematics (STEM) in Ghana, I write to inform you that approval has been given to you to carry out the research activity from January, 2021 to April, 2023 in the three (3) GES TVET Schools in the Central Region.

Attached is an introductory letter to the Regional Director of Education to inform the selected schools for the research.

Please, all protocols regarding the COVID-19 pandemic should be observed and adhered to strictly.

Thank you.

Yours faithfully,

Dr. Kwabena Remeh Tandoh
Deputy Director General (R&D)
P/Dir. Director General

cc: The Director-General, GES, Accra
The Deputy Director-General (R&D), GES, Accra
The Director, Schools and Instruction, GES, Accra
Appendix I: Sample of Privacy Notice to Participants

Privacy Notice – Gatekeepers and Participants
Faculty of Education University of Cambridge 184 Hills Rd, Cambridge CB2 8PQ.

Study on [Making a choice out of the norm: the lifeworld of young women pursuing STEM-TVET in senior high technical schools in Ghana]

Dear ……………………………………………………………,

I would like to share with you some details about how I will handle the information that will be gathered in the study and how the study will comply with the recently introduced EU General Data Protection Regulation (GDPR).

Who will process the students’ personal information?
My supervisors and I in the Faculty of Education at the University of Cambridge will be the only ones with access to the information.

What is the purpose and legal basis of the processing?
The collected personal information will be used to carry out academic research in the public interest. The data processing is necessary for the analysis of the lived experiences of young women who pursue STEM-TVET in GES-TVET institutions in Ghana, which can provide information regarding measures to ensure more young women choose to pursue STEM-TVET in Ghana.

I will make notes and tape-record the interviews with young women. The probability of harm occurring as a result of participation in the study is not greater in and of itself than that ordinarily encountered in daily life. The tape recorder will be positioned between us to capture the whole conversation. Personal data will be gathered from the young women other than their ages and names.

What are the arrangements for data storage and security?
The audio recordings will be stored in an encrypted hard drive and will be eliminated from the memory cards in the audio recorder. A password will also be needed to access them. Pseudonymization of the participants’ personal information will take place so that no personal data will be stored along with the audio recordings. All data will be identified only by a code, so all the participants will remain anonymous.

How can you access your personal information?
Some rights under data protection legislation (including the rights to access personal information that is held about you, and asking for correction of inaccurate personal information, deleting personal information or receiving an electronic copy of the personal information you provided) are qualified or do not apply when personal information is processed solely in research or archival context. This is because Faculty of Education University of Cambridge 184 Hills Rd, Cambridge CB2 8PQ, graduate@educ.cam.ac.uk 74

of the integrity of, and the public benefits arising from, the research study can be affected by fulfilling these rights.

How long is the information kept?

Other exemptions from some data protection principles in an academic research context allow for collected personal data to be kept indefinitely. The audio recordings of the interviews with the young women will be kept for ten years after the study ends and separated from all personal information. They will be kept to allow different rounds of analysis during the whole duration of the study described in the information sheet and to serve as evidence of the findings obtained from these analyses. The notes made during the interviews will not contain any personal data; only
Privacy Notice – Gatekeepers and Participants

Faculty of Education University of Cambridge 184 Hills Rd, Cambridge CB2 8PQ.

Codes will be used to identify the participants and these will be kept indefinitely. The data that will be produced from the analyses of the audio recordings and notes will be (securely) kept indefinitely.

Who can you contact?

If you have any questions about the study, please contact me in person or at [email] or [phone]. You can also contact your headteacher, and I will be pleased to get in touch with you. If you have general questions about how personal information is used by the university, or want to exercise your rights, you can consult the University’s data protection webpages at https://www.information-compliance.admin.cam.ac.uk/data-protection. You can also contact the University’s data protection team (data.protection@admin.cam.ac.uk) or its data protection officer (dpo@admin.cam.ac.uk).

Any complaints?

If you do not agree with the way your information is handled, or with a response received from me or the university, you have the right to lodge a complaint with the Information Commissioner’s Office at Wycliffe House, Water Lane, Wilmslow, SK9 5AF (https://ico.org.uk/).

Yours sincerely,

Alice Amegah (Researcher/PhD Candidate)
University of Cambridge
Faculty of Education
Tel: +233 94475454543
Email: a.a.amegah@gmail.com

Thank you.
Appendix J: Sample of Course Information Sheet

STEM-RELATED COURSES

<table>
<thead>
<tr>
<th>Programmes</th>
<th>Offered? Yes/No</th>
<th>Number of Males</th>
<th>Number of Females</th>
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<tbody>
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<td>Autoobody Works</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor Vehicle Engineering</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Welding and Fabrication Technology</td>
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<td></td>
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<tr>
<td>Diesel Mech/Heavy Engine, Heavy Duty</td>
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</tr>
<tr>
<td>Industrial Mechanics</td>
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<td>Mechanical Engineering Technology</td>
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<tr>
<td>Small Eng. Repair</td>
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<td></td>
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</tr>
<tr>
<td>Electrical Engineering Technology</td>
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</tr>
<tr>
<td>Electrical Machine/Motor Rewinding</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agricultural Mechanization Technology</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Refrigeration &amp; Air-Condition Technology</td>
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<tr>
<td>Refrigeration &amp; Air-Condition Technology</td>
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<tr>
<td>Electronics Engineering</td>
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<td>Information Technology</td>
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<tr>
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<td>Computer Networking (CBT Option, For Girls Only)</td>
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<td>Software Development (CBT Option, For Girls Only)</td>
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<td>Database Management (CBT Option, For Girls Only)</td>
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<td>Architectural Drafting</td>
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<td>Building Construction Technology</td>
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<tr>
<td>Wood Construction Technology</td>
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<tr>
<td>Furniture Design &amp; Construction</td>
<td>Upholstery</td>
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<tr>
<td>Plumbing &amp; Gas Fitting Technology</td>
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<td>Creative Art Technology</td>
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## Appendix K: Sample of Upper Secondary School Selection Register

### CATEGORY A

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<th>S/N</th>
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<th>DISTRICT</th>
<th>SCHOOL NAME</th>
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<th>GENDER</th>
<th>PROGRAMMES</th>
<th>NO. OF PROG</th>
<th>STATUS</th>
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<tbody>
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<td>Anantin North</td>
<td>OLA Girls' Senior High, Kasarvadi</td>
<td>Kasarvadi</td>
<td>Girls</td>
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<td>Tana North</td>
<td>Soweto Girls' Senior High, Nalinana</td>
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<td>Girls</td>
<td>X X</td>
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</tr>
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</tr>
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### CATEGORY C

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C. Conditions for selection of schools
   Candidates with guidance and assistance from parents/guardians and school authorities:
   a. Must choose five (5) schools (1st - 5th choice).
   b. Must select programmes and accommodation in each school of choice.
   c. Candidates must list choices 1 - 4 in order of preference
   d. Candidate's 5th Choice must be from Category D
   e. May select four(4) choices from Category C and One(1) from Category D
   f. Cannot select more than two (2) schools from Category B
   g. Cannot choose more than one (1) School from Category A
   h. Candidates who desire to pursue purely Technical Programmes may select all 1st - 4th Schools from Technical/Vocational Category. Category E and must still select the 5th Choice from Category D

   • PRIVATE SHS and PRIVATE TVET SCHOOLS are not BENEFICIARIES of FREE SHS
   Candidates who desire to pursue courses in private schools should make their own arrangements with the Private SHS and PRIVATE TVET.

   NOTE: Regardless of the categories chosen, candidates must arrange their choices in order of preference.
Appendix L: Sample of Guidelines for Upper Secondary Schools Selection Process

**COMPUTERIZED SCHOOL SELECTION AND PLACEMENT SYSTEM (CSSPS)
GUIDELINES FOR SELECTION OF SCHOOLS FOR PLACEMENT (2019)**

As part of measures to ensure a smooth placement of qualified BECE candidates for 2019, the Ghana Education Service (GES) has put in place the following arrangements for the information of parents/guardians/candidates and the general public.

A. **Grouping of Schools**

All second cycle institutions have been grouped into CATEGORIES as follows:

a. Public Senior High Schools: Four groups namely Categories A, B, C and D
b. Public Technical/Vocational Institutions (Category E)
c. Private Schools -Senior High/Technical Vocational Institutions (Categories F & G)

The table below presents second cycle institutions that have facilities for special education for the Physically Challenged and Visually-Impaired Candidates.

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B. **Before Selection of Schools and Programmes**

Before making any selection of schools and programmes offered in these schools, parents are advised to note that all schools selected (1st to 5th) are considered in placement of candidates.
Appendix M: Sample of Interview Schedule

Interview schedule to explore the lived experiences and decision-making processes of young women pursuing technical programmes in GES TVET institutions in the Central region.

Introductory Questions

Introduction to a brief story about myself, my educational journey and experience on a STEM-TVET called ‘Girls in Mobile Phone Repairs’. Alderson and Morrow (2004, p.52-53) propose the steps below as a sympathetic technique to establish mutual respect, rapport and trust:

- Sitting at the same level, not too close or too distant, in a quiet, comfortable, private place.
- Asking for permission to make notes and tape record narratives.
- Letting young women hear their voices on the tape recordings upon request.
- Encouraging them by talking clearly, slowly and not too loudly, keeping eye contact, looking and sounding interested.

Demographic Data
Age
Region
School-Level
Course
Parental details (age, job (government, self-employed, private), educational attainment)
BECE results

Interview Questions

1. Can you tell me about how you decided to pursue STEM-TVET?
   Specific prompts: a personal decision? Imposed decision? Short-term decision? How did you feel? Did anyone guide the decision? Did you compare your decision to any other options?

2. Can you discuss how various significant factors and persons influenced your decision?
   Specific prompts: parents, peers, teachers, church, neighbours, educational policies, role models, NGO opportunities

3. Can you discuss your feelings about the course and how you are experiencing the course?
   Specific prompts: easy, challenging, expectations, consistent, support, discouragement from others or self, accessible, inclusive, sophisticated, expectations, negative feelings, positive feelings, enjoyment, dislike

4. Discuss your identity and how it is developing or changing as a young woman pursuing STEM-TVET
   Specific prompts: creative, ordinary, extraordinary, strange, brave, positively, negatively

5. Can you tell me how you feel about your future aspirations on this course?
   Specific prompts: expecting to succeed, expecting to fail, expecting to discontinue, persistent, short-term goals, long-term goals, relating to student, career and as a woman, usefulness, practicality, future relevance

6. Did you give up anything to be on this programme?
   Specific prompts: past, present, anticipated efforts

General Probes
- Can you tell me more about that?
- Is there more to that?
- What do you mean by that?
- Can you explain further?
- Are there other examples?
- You can tell me any time you want to stop.