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Factors Influencing Women's Participation in Stem Programmes in Ghana

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Abstract: ***The purpose of this study was to investigate factors that influence women's participation in STEM programmes in Ghana. A quantitative research approach with a descriptive survey as its design was employed. Respondents were 409 female students reading any of the STEM programmes from 3 public universities in Ghana. The instrument used in collecting data was a questionnaire. Data collected were coded and analysed using descriptive statistics from the SPSS. The study revealed that family and parental influence on STEM majors, societal influence and stereotypes, motivation, and mentorship are key factors serving as a major influence on female participation in STEM programmes. The study recommended among others that parents, guardians, chiefs, and opinion leaders in societies should get involved in encouraging girls and women into STEM education.***

Keywords: STEM, Participation, Motivation and Mentorship, Stereotypes, Influence

1. Introduction

Science, Technology, Engineering, and Mathematics (STEM) education is an approach that instructs science and mathematics disciplines by integrating technology and engineering (Bybee, 2010) . STEM Education has become an international topic of discussion over the past decade due to the changing global economy and workforce needs. A substantial body of research shows that many students develop increasingly negative attitudes to school science and mathematics across the primary and early secondary school years (Nardi& Steward, 2003; Rennie et al.2001). STEM forms an integral part of our daily lives irrespective of the sector we find ourselves and a lot of work needs to be done to promote appreciation for STEM in the early stages of education. According to Anamuah-Mensah (2000), the utilization of science, mathematics, and technology has been interlinked with the improvement in productivity and wealth creation of a nation. Saah and Asiedu-Addo (2021) are of the view that girls' and women's participation in STEM education needs to be considered in the context of their overall access to, and participation in, education. While access to education for girls and young women has globally improved, important disparities persist both among and within regions and countries.

2. Literature Survey

A renewed commitment toward achieving parity in science education has been re-echoed in the policy goals (1 and 10) of the Education Strategic Plan aimed at providing girls equal opportunity to participate at all levels of education (MOE, 2003). Significant progress has been made in higher education, where the enrolment of female students almost doubled between 2000 and 2014, with young women constituting the majority of students at Bachelor's and Master's degree levels globally. However, the percentage of female students who continue with doctoral degrees drops by more than 7% compared to those enrolled at the Master's level (UIS, 2016). According to the Program for International Student Assessment (PISA, 2018) reports, engagement in science is determined by two factors – the way that girls and boys perceive themselves, that is, what they are good at and what is good for them, and their attitudes towards science. In terms of the population worldwide, women are more than men, yet men continue to outnumber women in STEM, especially at the upper levels of these professions (Ceci et al., 2009). In the basic education level in Ghana, girls and boys take mathematics and science courses in roughly equal numbers, and about as many girls as boys leave high school prepared to pursue science and engineering majors in college. Among first-year college students, women are much less likely than men to say that they intend to major in. By graduation, men outnumber women in nearly every science and engineering field, and in some, such as physics, engineering, and computer science, the difference is dramatic, with women earning only 20 percent of bachelor's degrees (Hill et al., 2010).

Women's representation in STEM declines further at the graduate level, and yet again in the transition to the workplace. Women continue to be underrepresented in the most mathematically intensive fields in STEM (National Science Foundation, 2016). Debate on gender equity in education currently revolves around females in mathematics and science domains. Much of the debate about school science and mathematics, therefore, has focused around

mathematics and science performance between girls and boys. Examination results have consistently indicated that males perform better than girls in mathematics and sciences at secondary school. The Third International Mathematics and Science Study (TIMSS) conducted in 1995 revealed significant gender differences in mathematics literacy in 18 of the 21 countries at the final year of secondary school (Keller, 2002; Mullis et al., 2000). As a result, women struggle to enter many of the STEM fields that have traditionally been dominated by men. In part, these gaps reflect pre-college choices made by men and women, but also to a large extent underpin gender disparities in various academic indicators linked to STEM, including educational outcomes and university enrolment. The participation of women in the sciences and most of all in the STEM industries should be a right and not a privilege. The workplace barriers that many studies have established to be related to gender issues need to be addressed before equality and parity can be achieved (Committee for Economic Development of Australia (CEDA), 2013; United Nations, 2010).

Drawing on a broader social cognitive perspective, career pathways encompass the ability to pursue a career and 7the motivation to employ that ability (Eccles, 2009). Without being good at mathematics and science, it is probably difficult to pursue a STEM-related job. However, being capable in mathematics and science does not necessarily mean that an individual will enjoy STEM-related activities or even pursue a STEM career. Therefore, in addition to cognitive ability, the competence beliefs, interests, and values that one attaches to relevant subject domains play a key role in career decision-making. When individuals feel capable and interested in mathematics and science, they are more likely to pursue STEM occupations (Wang et al., 2015). The need for gender equality in access and participation in the scientific fields is of paramount importance. Looking in from the outside, STEM can often seem like an intimidating field and there is the need to push past the fear of the unknown in order to continue denying false stereotypes/narratives. Issues such as discrimination in hiring and promotion, harassment, pay gaps, treatment by co-workers, balancing work and life, and lack of corporate policies supporting career development could discourage new entrants from pursuing STEM careers or spur current ones to exit (Funk & Parker, 2018). It is essential to eliminate systemic gender disparities, where that persist, amongst girls and boys, throughout the education system – in enrolment, achievement, and completion; in teacher training and career development; in curriculum, and learning practices and learning processes. A meta-analysis found that parental gender stereotypes reflecting male/female roles, interests, and abilities were linked to children's gender schemas about others and their attitudes about gender occupational roles (Tenenbaum & Leaper, 2003). Some cross-national studies indicate that greater cultural inequities between males and females are associated with larger gaps in mathematical performance favouring males (Hyde et al., 2006; Baker, 2013). Although there are significant methodological concerns with much existing research, several recurring, though not universal, there are certain details that are being overlooked. A lot of studies have been done on STEM education worldwide yet women are still underrepresented in their schools and in the work places. In this study, the researchers aimed at investigating some of the factors that influence female participation in STEM-related programmes in Ghana.

3. Methodology

This study employed a quantitative research approach with a descriptive survey as its design. As this study sought to assess the factors that affect women's participation in STEM-related fields, the study population came from female students in STEM programs who were purposively selected at 3 public universities in Ghana.

In all, *409* respondents were used for the study. This was made up of 130 students reading any of the STEM programs from University A, *97* students from University B, and *182* from University C. The questionnaire was used to elicit information on factors that influence female participation in STEM and also used to examine the extent these factors influence females in the choice of STEM careers. The Questionnaire was developed and measured based on all related literature that was reviewed and additional variables suggested in a pilot test which was conducted using a sample of 50 students in STEM-related programmes that were excluded from the participants in the main study. The pilot study assisted the researchers to check the effectiveness, validity, and reliability of the questionnaire All inputs in the forms of comments, suggestions, ideas, and proposals were taken into consideration to improve the level of reliability of the instrument.

A technique for measurement of the level of responses by Likert cited in Cohen et al. (2005) was adapted to develop the questionnaire in Parts Two and Three. Due to the uni-dimensionality property of Likert scales, the questionnaire consisted of pre-determined questions that were administered to the respondents and were ranked relative to one another by assigning a score to each of the respondents' positions. The responses from the questionnaires were coded and analysed quantitatively with descriptive statistics using International Business Machine Statistical Package for the Social Sciences (IBM-SPSS) version 20.

4. Results and Discussion

The researchers identified some factors that influence female participation in STEM programs. These factors, identified from the literature were grouped into four major factors: Society/Stereotypes, Family and parental influence on STEM majors, School factors, and motivation/mentorship.

Society/ Stereotypes

In this study, nine (9) items were extracted from literature as factors associated with Society/Stereotypic influence on STEM majors and the results are shown in Table 1.

The minimum and maximum in this analysis is of the rating scale of 1: Strongly Disagree, 2: Disagree, 3: Neutral, 4: Agree, 5: Strongly Agree.

Table 1: Frequency Distribution of Societal/Stereotypic influence on STEM Majors

Items	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	N (%)	N (%)	N (%)	N (%)	N (%)
1) From an early age, girls are not encouraged to pursue STEM subjects in school	78 (19.1)	62 (15.2)	56 (13.7)	116 (28.4)	97 (23.7)
2) Women are less likely than men to believe that they can succeed in these fields	81 (19.8)	72 (17.6)	56 (13.7)	123 (30.1)	77 (18.8)
3) Women face discrimination in the recruitment process, hiring and promotions in STEM careers.	59 (14.4)	63 (15.4)	67 (16.4)	127 (31.1)	93 (22.7)
4) Women face harassment, pay gaps and ill treatment by their colleagues and superiors.	53 (13.0)	67 (16.4)	79 (19.3)	121 (29.6)	89 (21.8)
5) Women are just less interested in science, technology, engineering and mathematics than men	72 (17.6)	62 (15.2)	61 (14.9)	135 (33.0)	79 (19.3)
6) It is more difficult to build a career while balancing work and family responsibilities in STEM careers.	53 (13.0)	77 (18.8)	58 (14.2)	138 (33.7)	83 (20.3)
7) Girls who study mathematics and science often face negative pronouncements from the society.	142 (34.7)	125 (30.6)	47 (11.5)	59 (14.4)	36 (8.8)
8) Society has a false belief that science-related subjects are more suited for boys.	59 (14.4)	60 (14.7)	35 (8.6)	134 (32.8)	120 (29.3)
9) Females who pursue science related courses and have a higher education cannot have successful marital lives.	202 (49.4)	83 (20.3)	38 (9.3)	50 (12.2)	36 (8.8)

The analysis in Table 1 revealed that*213* (*52.1%*) of the total respondents agreed that from early age girls are not encouraged to pursue STEM subjects in school with only *140* (*34.3%*) in disagreement. Out of the *409* respondents, *200* (*48.9%*) agreed that women are less likely than men to believe that they can succeed in STEM fields, whilst the rest, *153* (*37.4*)*%* disagreed. The study further revealed that*220* (*53.8%*) and *210* (*51.4%*) cumulatively agree that women face discrimination in the recruitment process, hiring and promotions, in STEM careers and women face harassment, pay gaps and ill treatment by their colleagues and superiors respectively. It can be seen from Table 1 that *214* (*52.3%*) of the respondents cumulatively agreed that women are just less interested in STEM programs than men with *134* (*32.8%*) in disagreement. In response to the item, "it is more difficult to build a career while balancing work and family responsibilities in STEM careers", *221* (*54%*) agreed and *130* (*31.8%*) disagreed. The analysis also revealed that, *95* (*23.2%*) agreed that girls who study mathematics and science often face negative pronouncements from the society and *267* (*65.3%*) of the respondents disagreed. However, *254* (*62.1%*) agreed that, society has a false belief that science-related subjects are more suited for boys with only *119* (*29.1%*) in disagreement. In response to the statement, "females who study science related courses and have a higher education cannot have successful marital lives", only *86* (*21.0%*) agreed whilst, *285* (*69.7%*) disagreed.

Family/ Parental influence

Five (5) items were extracted from literature as factors associated with family/ parental influence on STEM majors and the results are shown in Table 2. The analysis in Table 2 investigated how the family/ parents of respondents influenced them in pursuing a STEM major.

Table 2: Frequency Distribution of Family/ Parental influence on STEM Majors

Items	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	N (%)	N (%)	N (%)	N (%)	N (%)
1) My family encouraged me to pursue a STEM program	41 (10.0)	50 (12.2)	46 (11.2)	124 (30.3)	148 (36.2)
2) I have a female relative who works in a STEM field and encourages me.	46 (11.2)	77 (18.8)	58 (14.2)	108 (26.4)	120 (29.3)
3) My parents have a mindset that promotes strong STEM identities for the girl child.	19 (4.6)	46 (11.2)	53 (13.0)	144 (35.2)	147 (35.9)
4) My parents believe STEM is for everyone.	13 (3.2)	34 (8.3)	55 (13.4)	118 (28.9)	189 (46.2)
5) My family believes in the ability of the girl child to excel in whatever she puts her mind to.	11 (2.7)	19 (4.6)	23 (5.6)	115 (28.1)	241 (58.9)

The results of the study in Table 2 revealed that, *272* (*66.2%*) and *228* (*55.7%*) respectively agreed that the influence to study in a STEM program came from encouragement from either their family or a female relative who works in a STEM field. In addition, *291* (*71.1%*) and *307* (*75.1%*) respectively agreed their parents have a mindset that promotes strong STEM identities for the girl child and that they believe STEM is for everyone. Majority of the respondents, *356* (*87.0%*) agreed that they had families who believe in the ability of the girl child to excel in whatever she puts her mind to, and only *30* (*7.3%*) disagreed.

School Factors

The study investigated how school factors influenced student's choice in STEM careers. Table 3 presents the frequency distribution of influence of school factors on respondents' pursuit of STEM programmes. Eight (8) items were extracted from literature as factors associated with school influence on STEM majors and the results are shown in Table 3.

Table 3: Frequency Distribution of School Factor influence on STEM Majors

Items	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	N (%)	N (%)	N (%)	N (%)	N (%)
1) I chose my major because I was good at math and science in high school	17 (4.2)	49 (12.0)	60 (14.7)	169 (41.3)	114 (27.9)
2) Students in my school are constantly motivated to pursue STEM programmes.	14 (3.4)	52 (12.7)	77 (18.8)	169 (41.3)	97 (23.7)
3) My teacher's positive attitude was a reason for choosing a STEM programme.	32 (7.8)	64 (15.6)	59 (14.4)	125 (30.6)	129 (31.5)
4) My school has enough teachers in the STEM programme.	15 (3.7)	63 (15.4)	91 (22.2)	144 (35.2)	96 (23.5)
5) I participated in mathematics and science focused extra-curricular activities	26 (6.4)	74 (18.1)	75 (18.3)	145 (35.5)	89 (21.8)
6) My classroom environment was gender sensitive	35 (8.6)	66 (16.1)	82 (20.0)	125 (30.6)	101 (24.7)
7) My school had adequate science laboratory/ technical/ICT equipment.	30 (7.3)	74 (18.1)	78 (19.1)	138 (33.7)	89 (21.8)
8) My school counselor or high school teacher encouraged me to choose my programme.	49 (12.0)	84 (20.5)	50 (12.2)	119 (29.1)	107 (26.2)

The result in Table 3 revealed that most of the respondents, *283* (*69.2%*) and.*266* (*65.0%*)acknowledged that they chose a major in STEM because they were good at mathematics and science in high school and that students are constantly motivated to pursue STEM programmes in their respective pre-tertiary schools. The analysis also revealed that, *254* (*62.1%*) agreed that their teacher's positive attitude had an influence in them choosing a STEM programme, and *240* (*57.3%*) chose a STEM major because they had enough teachers in the STEM programme. In agreement, *234* (*57.3%*) pursued a programme in STEM because they mostly participated in mathematics and science focused extra-curricular activities. In addition, *226* (*55.3%*)had a classroom environment which was gender sensitive and *227* (*55.5%*) had adequate science laboratory/ technical/ICT equipment. In response to item 8, *226* (*55.3%*) agreed that they were motivated to choose a STEM program by their school counsellor or high school teacher.

Motivation/Mentorship

Eight (8) items were extracted from literature as factors associated with Motivation / Mentorship influence on the choice of STEM majors and the results are shown in Table 4.

Table 4: Frequency Distribution of Motivation/Mentorship Influence in STEM Majors

Items	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	N (%)	N (%)	N (%)	N (%)	N (%)
1) My role model influenced me.	35 (8.6%)	79 (19.3)	65 (15.9)	116 (28.4)	114 (27.9)
2) I attended a science camp and I really liked it.	53 (13.0)	106 (25.9)	69 (16.9)	94 (23.0)	87 (21.3)
3) I chose my major because I see great career opportunities in the STEM field.	7 (1.7)	16 (3.9)	44 (10.8)	161 (39.4)	181 (44.3)
4) I chose my major because I want to encourage young women in pursuing STEM majors.	9 (2.2)	21 (5.1)	36 (8.8)	149 (36.4)	194 (47.4)
5) I chose my major because I was good at math and science in high school	17 (4.2)	38 (9.3)	65 (15.9)	170 (41.6)	119 (29.1)
6) I chose my major because I feel I will be capable in this field.	10 (2.4)	12 (2.9)	23 (5.6)	182 (44.5)	182 (44.5)
7) I chose my major because I am academically prepared to succeed	7 (1.7)	16 (3.9)	32 (7.8)	165 (40.3)	189 (46.2)
8) I chose my major because I want to pursue this major	5 (1.2)	20 (4.9)	38 (9.3)	166 (40.6)	180 (44.0)

The result shows that more than half, *342* (*83.7%*) of the respondents in Table 4 chose to study a STEM programme because of great career opportunities in the STEM field. Also; *230* (*56.3%*) and *343* (*83.8%*)stated, they were influenced to study a STEM major by their role models, and that they want to encourage young women in pursuing STEM majors. The analysis revealed that *181* (*44.3%*), *289* (*70.7%*), *364* (*89.0%*), *354* (*86.5%*) and *346* (*84.6%*) entered the STEM field due to their own motivation. The finding from this analysis agreed strongly with some of the research findings by Rosenzweig and Wigfield, (2016) that a systematic review of studies targeting students' motivation showed that certain interventions had positive effects on both motivation and academic outcomes. For example, targeting students' beliefs about value, interest, or intrinsic motivation or how to deal with success or failure.

Extent to which the identified factors influence women in the choice of STEM careers

An analysis was done to investigate which of the factors: society/ stereotypes, family/ parental influence, school factors, motivation/ mentorship had the most influence in the choice of STEM careers. This is presented in Table 5.

Table 5: Frequency Distribution of the extent the identified factors influence STEM Major Choices.

	Response Categories	Frequency (N)	Percentage (%)
	Society / Stereotypes	30	7.3
	Family / Parental Influence	98	24.0
	School factors	95	23.2
	Motivation / Mentorship	186	45.5
	Total	409	100.0

The responses from the respondents show that motivation and mentorship is the factor with the highest frequency of *186* (*45.5%*). This implies that, when young females are engaged, mentored and empowered by highlighting rising women in STEM and their prospective STEM careers, girls' participation in STEM education in Ghana will be on the rise. This is in agreement with findings of previous studies that girls' interest and confidence in their abilities increase when they are exposed to positive STEM role models (Hughes et al., 2013; González-Pérez et al., 2020). Observing and interacting with women who are experts in STEM fields improve girls' attitudes towards STEM (Hughes et al.2013). Also, student motivations do mirror their social background reporting a greater influence from family support in their motivation to persist.

In all the factors influencing enrolment in a STEM major, the results from the analysis are supported where many students referred to early encounters with STEM including encouragement from their role models and mentors as being influencers in their choices to seek after and persevere in a STEM field. Being motivated by a challenge, matches the profile of a highly motivated and determined individual as well as embodying internal self-concept motivation. The students in this study frequently selected internal motivation and motivation from mentors as factors in their decisions to choose and persist in STEM majors. Thus, the study findings across demographics are in line with other researches on female persistence in STEM majors (Ackerman et al., 2013) Successful female role models demonstrate that it is possible to overcome traditional gender barriers. Also, female role models stand the chance of undermining traditional gender stereotypes about women; consequently, they will thus reduce the persistent effect of gender stereotype in most societies (Lockwood, 2006).

5. Conclusion

This section draws conclusions on factors that influence women's participation in stem-related programs in Ghana. It can be concluded from the discussion that family and parental influence on STEM majors, society influence and stereotypes, motivation and mentorship are key factors for female participation in STEM programmes. Successful female role models demonstrate that it is possible to overcome traditional gender barriers about women to reduce the effect of gender stereotypes in most societies. Johnson (2006) reported that many teachers lack resources needed to effectively implement interactive learning experiences for their students. Understanding these challenges can help facilitate the implementation and success of STEM programs. Teacher perceptions of STEM education influence how they design their STEM units and their methods of delivery of instruction.

6. Recommendations

From the findings and conclusions, the following recommendations are made:

- Parents, guardians, chiefs and opinion leaders in societies should get involved in encouraging the inclusion of girls and women in STEM education.
- The education of every child starts from the family as it is said "charity begins at home". So, to prevent gender bias in STEM, parents/caregivers and teachers should work to counter stereotyping and discrimination starting from early childhood.
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- School authorities should support girls' involvement in activities that can build their confidence in STEM fields. Teachers in STEM classrooms should invest the time to find and recruit mentors for their female students.
- Government should invest in teacher training and gender-responsive technology and innovation to reverse the trend, particularly in the hinterlands because that is where the biases are felt more.
- Parents and teachers should continue to motivate and encourage more females to study STEM programmes.

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Author Profiles

Jemima Saah, Jemima Saah is a highly skilled young lady with a Bachelor's and a Master's degree both in Mathematics Education from the University of Education, Winneba. She is currently pursuing a PhD degree in Mathematics Education at the same university and teaches mathematics at a senior high school in Ghana, where she inspires her students to see the relevance of mathematics in their everyday lives. She is also an advocate for diversity and inclusion in STEM fields and mentors young women interested in pursuing careers in mathematics and related fields.

Dr. Gloria Armah is a Senior Lecturer at the Department of Mathematics Education at the University of Education, Winneba in Ghana. She is a proactive and an enthusiastic mathematics educator with 19 years of teaching experience at the university level. She holds a PhD degree in Mathematics Education. She is an organized and efficient mathematics educator with an enquiring mind and teaches courses and supervises theses at both the undergraduate and graduate levels. Her research interest is mathematics education with special interest in gender issues in Mathematics and Statistics Education. She has "Teaching for Understanding" as one of her philosophies of teaching. She is very motivated to equip young minds to learn more about mathematics and highly passionate in mentoring young women to do well in mathematics and its related fields. Dr. Armah is a former Head of the Department of Health Administration and Education and currently, she heads the Department of Physics Education of the University of Education, Winneba in Ghana. She is a member of the African Women in Mathematics Association (AWMA), Ghanaian Women in Mathematics, Organization for Women in Science for the Developing World (OWSD), among others.

Prof. Samuel Kwesi Asiedu-Addo is an experienced University lecturer and expert in the teaching and learning of mathematics and mathematics education. He is a highly motivated and enthusiastic individual with a PhD degree in Applied Mathematics. He is dedicated to all jobs most especially the teaching and learning of mathematics to students of higher learning. He is an astute researcher in differential equations, mathematical modeling, statistical modeling and mathematics education. His passion for mathematics is par excellent. Prof. Asiedu-Addo is a good communicator with excellent organization skills. He is a former National President of the University Teachers Association of Ghana (UTAG), former National President of the Mathematical Association of Ghana (MAG) and Dean, School of Graduate Studies, University of Education, Winneba. Under the supervision of Prof. Samuel Kwesi Asiedu-Addo, many students have graduated with PhD and MPhil degrees in mathematics and mathematics education in many universities across Ghana. His competence and teaching skills can be testified by many renowned universities in Ghana including the UEW, UCC, KNUST, UMaT and the AAMUSTED, not forgetting the University of Vermont in the far away USA.

John Takyi-Bondzie is a dedicated and highly motivated person who has been doing academic job in Senior High School for the past 13 years. He is currently pursuing his PhD in Mathematics Education with the University of Education, Winneba. He holds both Bachelors and MPhil degrees in Mathematics Education all from the same University. His research area is in STEM Education and he aspires to become a consultant in the area.