British Journal of Education, Society & Behavioural Science
4(1): 120-138, 2014

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Differences among Female Students in Science and Technology-based University Programmes in Their Motivation to Learning Science in Ghana

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Authors' contributions

This work was carried out in collaboration between both authors. Author KDA designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author FM managed the analyses of the study, the literature searches and wrote the conclusion. Both authors read and approved the final manuscript.

Original Research Article

Received 7th August 2013
Accepted 1st October 2013
Published 21st October 2013

ABSTRACT

The study was aimed at investigating differences among female students in science and technology-based university (STU) programmes in their motivation in learning science.
The study utilized cross-sectional descriptive survey design. The theoretical framework for this study was based upon the Self-determination theory of motivation and Social Learning Theory of Career Decision-Making**.**
The target population comprised 1192 final year female students pursuing science and technology-based programmes at the Kwame Nkrumah University of Science and Technology, Kumasi, Ghana. 328 final year female students in the 2008/2009 academic year pursuing engineering, medicine, pharmacy and CS/ICT formed the sample. A Self-Report Survey Questionnaire was designed and administered. It had reliability coefficient of 0.88 for section B using Cronbach alpha formula.
The study revealed that parents, especially fathers, involvement in science and technology competitions, students' involvement in science clubs, status of jobs in STU careers, and self-motivation influenced female students' choice of science at the senior high school

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(SHS) level and in STU programmes. One-way between group analysis of variance (ANOVA) and Hotchberg GT2 Post hoc analyses indicated that there were significant differences in motivation among some of the four groups of students.
It was concluded that female students in various STU programmes at the university level are motivated by different factors.

Keywords: Science and technology education; tertiary institutions; women; motivation; science and technology-based university programmes.

1. INTRODUCTION

The government of Ghana has over the years put programmes in place to encourage the study of science and technology at all pre-tertiary levels in the country. These programmes have been tailored towards encouraging greater participation of women in science and technology programmes. Consequently, the Government of Ghana introduced the Science and Mathematics clinic for both boys and girls and incorporated technical drawing at the basic school level towards encouraging students to actively participate in science and technology [1]. In addition to this the Ghana government in conjunction with the Ministry of Education indicated that vigorous efforts will be made to increase the accessibility of females to apprenticeable and non-traditional areas of technical education and training to increase female participation on Technical and Vocational Education and Training in Ghana [1]. However, according to a report by [2], few women enter science, technology, engineering or math fields (often referred to as STEM fields), which tend to be higher paying than “pink collar jobs” such as counseling or social work. In spite of the call by President Obama for more women to go into STEM fields, women are still preparing themselves in a set of fields that tend to be lower wage skills and that is a concern. This challenge of under representation of women in STEM areas is a global phenomenon and has political and socio economic implications for Ghana. Notwithstanding, it is believed that the wholistic education of the girl-child will be key to socio economic transformation of women in Ghana in particular and Africa in general. Besides, African countries are generally classified as underdeveloped due to the relatively low level in their scientific and technological development. Thus, genuine integrated socio-economic transformation cannot be achieved in developing countries unless women are fully incorporated into Science and Technology education at the tertiary level and in all spheres of life.

Education raises awareness “to be engaged as thoughtful citizens and to become meaningfully involved in the change process as co-responsible thinkers, actors and leaders” [3]. Apart from being more than half of the world’s population, since women have a huge influence on the well-being of their families and societies, the effect of women’s education on population growth, economic growth and poverty is enormous. Unfortunately, the culture of marginalisation and discrimination of the women folk in education has persisted to this day. They opined for example, that in the past (pre and post-independence), in many sub-Saharan African (SSA) countries, fewer places were available for girls and women in schools and universities. Although currently as many women and girls as men and boys can be admitted in a school/ university, still fewer women get selected to join the public schools and universities. Analysis of examination results and selection of students to join public secondary schools and tertiary level institutions from 10 countries showed that for every 100 boys who passed the secondary school examination and were eligible, 15 got a chance to

go to a public university while for every 100 girls who passed the examination and were eligible only 7 got a chance [3].

When a country educates its citizens, economic productivity rises, maternal and infant mortality rates fall, fertility rates decline, and the health and educational prospects of the next generation are improved [4]. Unfortunately, this cannot be said about most African countries because they have a shortage of all kinds of qualified personnel in higher education with the shortages being worse in the natural sciences, healthcare and engineering fields. For instance, there is a massive shortage of health workers globally but most intensely in developing countries, which has considerably constrained achievement of health related millennium development goals. Many countries in the world including developing countries as well as developed nations like UK and USA are not producing sufficient numbers of health workers whilst in developing countries like Sub-Saharan Africa, this is partly because of lack of medical training institutions [5]. Solving the problem of health workforce and other STEM career shortages will require the united effort of several national and international agencies, and this frantic effort to increase female participation cannot be compromised.

[6] indicated that women constitute almost 51% of Ghana's population and form a greater percentage of the population involved in economic activities, yet the majority of the female workforce is classified as semi-skilled or unskilled workers. From the foregoing, it is clear that it is not enough to call for equality in education but rather equity which allows for curriculum diversity that addresses the needs of various student constituencies and which takes socially inherited inequities into account. The International Labour Office commissioned a research project to determine the level of participation of women in "non-traditional occupations" (technical subjects and related jobs) in some third world countries. The study indicated that a life-cycle approach has to be adopted to overcome the challenges that confront women in gaining access to education and training and in utilizing this training to secure better employment. This includes: improving the access of girls to basic education; overcoming logistical, economic and cultural barriers to apprenticeships and to secondary and vocational training for young women - especially in non-traditional occupations; taking into account women's home and care responsibilities when scheduling workplace-based learning and entrepreneurship training; and meeting the training needs of women re-entering the labour market and of older women who have not had equal access to opportunities for lifelong learning [7].

The theoretical framework for this study was based upon the Self-determination theory of motivation and Social Learning Theory of Career Decision-Making. According to [8] self-determination theory (SDT) is a macro theory of human motivation and personality, concerning people's inherent growth tendencies and their innate psychological needs. It is concerned with the motivation behind the choices that people make without any external influence and interference. SDT focuses on the degree to which an individual's behaviour is self-motivated and self-determined. SDT is centred on the belief that human nature shows persistent positive features, that it repeatedly shows effort, agency and commitment in their lives that the theory calls "inherent growth tendencies." People also have innate psychological needs that are the basis for self-motivation and personality integration. On the other hand, Social Learning Theory of Career Decision-Making explains how educational and occupational preferences and skills are acquired and how selection of courses, occupations, and fields of work are made [9]. The theory identifies the interactions of genetic factors (e.g., race), environmental conditions (e.g., social and economic forces), learning experiences (e.g., associative and instrumental), and performance (task) skills (e.g., work habits). It is posited that each of these influencers plays a part in all career decisions that are

made, but different combinations of interactions of these influencers produce a multitude of different career choices that individuals make [9].

Some studies have reported low participation rate in specific fields in science and technology. Some of the studies reveal that even though more and more girls and boys are enrolling in primary and secondary schools in many regions of the world and that enrolment of women at the tertiary level has increased steadily and women are now approaching the 50 per cent mark of the total number of students worldwide there is still much to be desired. Even so, women are unevenly under-represented in science and technology (S&T) studies at all levels of education and in the workforce in different regions [10]. A recent OECD report [11] found that in most OECD countries, less than a third of all students in advanced chemistry, physics or biology classes in secondary schools were women. However, in the United States, women represent only 15 per cent of students enrolled in advanced computer science [7]. But according to the UNESCO Institute for Statistics, in Latin America and the Caribbean, 43 per cent of science and technology researchers are women, exceeding the world average of 28 per cent [10]. In most Central Asian countries reporting data, the figure is about 50 per cent; in the Commonwealth of Independent States, 43 per cent and in Africa, about 31 per cent [7]. Why is there a wide gap in some parts of the world and not in others? It is more a question of encouragement, pervasive gender roles and attitudes rather than aptitudes, according to the OECD. Girls are far less likely than boys to study engineering or computer or physical sciences. According to this report, though women earn more than half of the university degrees in the OECD countries, yet they receive only 30 per cent of degrees in science and technology. The percentage of female graduates advancing to research is even smaller, representing less than 30 per cent of science and technology researchers in most OECD countries and only 12 per cent in countries such as Japan and the Republic of Korea [7]. For women hold more than 60 per cent of Information and Communication Technology (ICT)-related jobs in OECD countries, only 10 to 20 per cent are computer programmers, engineers, systems analysts or designers. The large majority of women are in secretarial, word processing or data-entry positions, requiring rather routine, low-level skills or limited technical training.

[12] researched on why students choose or reject physics and found that students entering secondary schools did so with a variation of mathematical abilities, aptitudes, personalities and home backgrounds. Some would have been immersed in a positive scientific or technological culture at home, with parents encouraging them to join in scientific and technical activities and thus would have gained confidence in practical problem solving. In other words most of their parents were either scientists or technologists or were enthusiastic about science. However, [13] on why choose physics – in Norway and Finland observed that parents, siblings and friends are not rated as important influence factors on the choice of physics. This is surprising, because such factors have been identified as strong influences on young people's educational choices [12]. [14], in a study on factors affecting students' choice of science and engineering, observed the importance of the quality of the science teachers and extra curricular activities in science as encouraging factors for career decision.

Accordingly, [15] in a study found that stereotyped attitudes of society affected Ghanaian women's participation in engineering careers. It was also observed that the low participation of women in engineering careers was due to the poor performance of females in science and mathematics. The results also showed that natural curiosity, which comprised interest in Mathematics and Science, and the desire to do engineering jobs, had the most influence on the career choices of the women engineers. For example, from 2000/2001 to 2005/2006, the enrolments of males were more than females in all three public universities, namely Kwame

Nkrumah University of Science and Technology, University of Ghana and the University of Cape Coast. Averagely, the percentage enrolment of females in the six academic years of the University of Ghana, Kwame Nkrumah University of Science and Technology and the University of Cape Coast, was 33%, 24% and 24% whereas that of the males was 67%, 76% and 76% respectively. Kwame Nkrumah University of Science and Technology enrolled the largest number of females into science and technology programmes (55%) as compared to the University of Ghana (25%) and the University of Cape Coast (20%) during the period in under review as observed. The different participation of males and females in Ghanaian education at the Universities is very alarming in relation to the population dynamics of the country as indicated by [6] as males constitute 49.5% of the Ghanaian population whereas females constitute 50.5%.

In spite of the success claimed by the STME Clinic for increasing the number of females in science and technology-based programmes and the various interventions put in place by the Government of Ghana to improve science and technology studies and to encourage greater participation of women, the proportion of female students pursuing science and technology-based programmes at the University of Cape Coast, Kwame Nkrumah University of Science and Technology and the University of Ghana is low compared with female participation in the humanities. In the light of this, it seems worthwhile to investigate issues of motivation related to the choice of science and technology-based university (STU) programmes by females at the university level in Ghana.

1.1 The Purpose of the Study

Based on the problems highlighted, the study aimed at investigating motivation that underpin female students' participation of science and technology-based programmes at the Kwame Nkrumah University of Science and Technology, Kumasi, Ghana. The purpose of the study was therefore to:

1. Find out the factors that motivate female students' choice of science at senior high school (SHS) as well as science and technology-based university (STU) programmes.
2. Investigate the relationship in motivation among female students pursuing different STU programmes

Four research questions were formulated to guide the study:

1. Which people motivated female students in various STU programmes to learn science while at the SHS level?
2. Which people motivated female students in various STU programmes to pursue their current programmes?
3. What factors motivated female students in various STU programmes to pursue their current programmes?
4. How do female students in various STU programmes differ in their motivation to learn science while at SHS?

One null hypothesis (H_o) was formulated for the study as follows:

1. There is no significant difference in motivation among female students to learn science at SHS level and to pursue STU programmes.

The outcome of the study would help educational policy makers, as well as implementers and curriculum developers to adopt appropriate strategies that will attract more female students into the field of science and technology. This would also help to encourage more female students to pursue careers in science and technology.

2. METHODOLOGY

2.1 Research Design

The study utilized cross-sectional descriptive survey design to investigate the differences among female students in science and technology-based university programmes in their motivation to learning science in Ghana. The purpose of using the survey design was to find out from the final year female students at KNUST their motivation to pursue SHS science and later science and technology-based programmes at the university level. The study involved four intact groups of final year female students from the KNUST pursuing engineering, medicine, pharmacy and computer science/information communication technology (CS/ICT). A Self-Report Survey Questionnaire with closed-ended and open-ended questions was designed and administered to final year female Science and Technology students in KNUST. The study looked at female students' motivation to pursue Science and Technology-based careers. Motivation was the dependent variable whilst the independent variable was the type of science and technology-based programme being pursued. The design made it possible for comparison to be made among the four groups of students and is therefore described as "between groups" design [16] that helped to test the hypotheses and answer the research questions. The rationale for the choice of a cross-sectional descriptive survey design is that it is of greater economy because results are procured faster than longitudinal surveys. Sampling has a greater scope regarding the variety of information required and further, it allows for higher quality of work as more accurate data can be provided under suitable conditions.

Sample surveys have some disadvantages when it comes to eliciting basic information required for every unit of the population. Errors due to sampling also tend to be higher for small sample sizes. However, considering the homogeneity and magnitude of the target population of this research, the advantages in descriptive sample survey far outweigh its disadvantages. The target population comprised all 1192 final year female students pursuing Science and Technology-based programmes at KNUST in the 2008/2009 academic year whereas the accessible population was 328 final year female students pursuing engineering, medicine, pharmacy and CS/ICT as the sample. KNUST was purposively selected because it offered the largest number of science and technology-based programmes. There were 135 female engineering students representing about 41% of the respondents, 75 female medical students, which represented 23% of the total number of respondents. The rest were 97 female pharmacy students whose percentage representation was 30% of the total number of respondents whereas 21 students of computer science/information communication technology responded to the questionnaire with 6% representation of the total number of respondents. The 328 female students who responded to the survey ranged in age from 19 to 43 with a mean age of 22.2 years and standard deviation of 2.3. Of the 328 female students used for the survey, 116 (35%) were from mixed Senior High Schools whereas 212 (64%) came from all female Senior High Schools across Ghana.

A Self-Report Survey Questionnaire with closed-ended and open-ended items was designed and administered to final year female Science and Technology students in KNUST. The questionnaire consisted of two sections (see Appendix). Section A elicited the respondents' personal data and background information. On personal data students were asked to provide their ages and to indicate the grades they had obtained at "A" level or SSSCE in physics, chemistry, biology and mathematics, as well as the type of programme they are pursuing at the university. The rest are the background information about students such as the person who encouraged them to pursue a programme in science at Senior High School, the parents' occupation and whether they have siblings who are in science and technology-based careers. Students were also asked to indicate when they decided to pursue a science and technology-based career, whether they have participated in the STME clinic and who motivated them to offer a science and technology-based course at KNUST. Section B consisted of eight statements about what motivated the female students to pursue science and technology-based programmes. For each statement students were asked to answer whether they strongly agreed, agreed, were undecided, disagreed, or strongly disagreed.

In developing the instrument career women in engineering, pharmacy, medicine and computer science/information communication technology (CS/ICT) in the Cape Coast Metropolis were asked to list factors they felt motivated them to pursue their careers in science and technology. Their responses were compared with that of the career choice model proposed by Woolnough (1994a) and developed into the questionnaire. The instrument was then pilot-tested on 25 female students pursuing Optometry, Medicine and CS/ICT at the University of Cape Coast (UCC). This was to determine the suitability of the questionnaire items as well the reliability of the instrument. Data for the pilot-test were collected in September 2008. The reliability coefficient was found to be 0.88 for section B using Crombach alpha formula. This value reflected the internal consistencies of the instrument indicating that items grouped together under motivation are highly correlated.

2.2 Procedure for Data Collection

Data for the study were collected in February 2009 at KNUST, Kumasi, Ghana. Access was gained to the research site through permission obtained from the Heads of Department of the various departments studying Science and Technology-based programmes especially Engineering, Medicine, Pharmacy and Computer Science/information communication technology (CS/ICT) at the Kwame Nkrumah University of Science and Technology (KNUST), Kumasi.

The researcher made two visits to the respondents in each case. In the first visit the time and place for the administration of the questionnaire were agreed upon. In the second visit the researcher met the students in the agreed lecture theatres to coincide with specific lectures to ensure that all students were present. The purpose of the study was explained to them through an introductory letter from the Head of Department of Science Education, UCC, presented by the researcher. Females in the final year pursuing Science and Technology-based programmes especially Engineering, Medicine, Pharmacy and CS/IT in the 2008/2009 academic year were the respondents. The researcher distributed the questionnaire to the final year female students at KNUST for each of the four programmes and stayed on until the respondents finished their responses and the answered questionnaires were collected on the spot. This census sampling method used by the researcher ensured 100% retrieval of questionnaire, while saving a lot of time compared with interview.

2.3 Data Analysis

The procedures used to answer the four research questions and to test the hypothesis were in two phases. The responses were grouped and analysed based on the sections of the questionnaire. The first phase involved analysis of section B using percentages and means to determine the extent to which students agreed or disagreed with the statements on motivation in the questionnaire. Section A was made of a number of questions and was also anlysed using percentages and means.

The second phase involved one-way analysis of variance (ANOVA) on motivation as the dependent variable (section B). The independent variable was the type of science and technology-based programmes pursued by the final year female students at KNUST, which are engineering, medicine, pharmacy and CS/ICT. The ANOVA was used to find out whether the differences in the mean of students' responses depended on the type of programme pursued. To determine what specific means were different, the results of the multiple comparison table was used. In this case, the Hotchberg GT2 tests were used to find out differences between specific student groups. The Hotchberg GT2 tests were used due to the different number of respondents per group (engineeering, 135; medicine, 75; pharmacy, 97; and CS/ICT, 21) presented for the study.

3. RESULTS AND DISCUSSION

3.1 Female Students' Motivation to Study Science at SHS Level and to Pursue STU Programmes

In analysing issues on motivation, female students' motivation to learn science at the SHS level was used as a proxy measure of their motivation in various STU programmes to pursue their current programmes. This is because their motivation to pursue STU programmes originated from the confidence gained by the students in doing SHS science. The first research question states "which people motivated female students in various STU programmes to learn science while at the SHS level?" Table 1 reports on students' responses about who encouraged them to study science at SHS. Table 1 shows that Students pursuing the four STU programmes were self-motivated (42.8%) on their choice of science at the SHS. The students claimed the interest generated in SHS science was as a result of the scientific materials they had at home such as computers, science fiction movies and scientific toys. The other group of people who encouraged them on their choice of science at the SHS were their fathers (21.7%) and both parents (15.4%) but rarely by mothers, siblings and relatives. However, teachers' role in encouraging female students' choice of science programmes at the SHS was very limited as only 5.7% of respondents chose teachers as their encouraging them to study science at the SHS level. This is surprising as studies by [17,14,18] have indicated that teachers influence students' choice of science at the SHS level.

Table 1. Distribution of students' responses on people who encouraged them to study science at SHS (%)

Responses	Engineering (N= 135)	Medicine (N= 75)	Pharmacy (N= 97)	CS/ICT (N= 21)	Total No (N=328)
Myself	36.6	58.1	40.4	38.1	42.8
Father	19.1	18.8	28.7	14.3	21.7
Both Parents	25.2	11.6	7.4	9.5	15.4
Teacher	8.2	4. 3	4.3	19.0	5.7
Friends	5.0	2.9	5.4	0	5.0
Mother	3.3	1.4	7.4	0	4.3
Siblings	2.6	2.9	3.2	0	2.7
Relatives	0	0	3.2	19.1	2.4

The second research question states "which people motivated female students in various STU programmes to pursue their current programmes?"Students' responses are presented in Table 2. This was to determine whether those who encouraged students to do science at SHS were the same people who motivated them to study science and technology-based programmes at KNUST. The table shows that generally female students were self-motivated (41.8%) to study STU programmes at the university level. The students claimed the interest generated in STU programmes was as a result of the scientific materials they had at home such as computers, science fiction movies and scientific toys. Other people who encouraged them include fathers (17.6%), and both parents (13.8%) on their choice of science and technology-based courses at KNUST but rarely mothers (3.4%), siblings (3.4%), teachers (3.1%), and friends (2.8%). These findings do not support [13] who claim that mothers, siblings and friends were very influential in students' choice of science and technology-based programmes. When the students were probed further they indicated that uncles, aunts, grandparents, pastors, imams and family friends and relations fall under the category of "others".

Table 2. Distribution of students' responses on people who motivated them to pursue STU programmes (%)

Responses	Engineering (N= 135)	Medicine (N= 75)	Pharmacy (N= 97)	CS/ICT (N= 21)	Total No (N= 328)
Self	20.6	60.7	51.7	88.8	41.8
Father	34.5	7.2	14.3	0	17.6
Others	15.2	20.3	8.8	11.2	14.1
Both Parents	18.8	11.6	12.1	0	13.8
Mother	0	7.2	5.5	0	3.4
Siblings	5.4	0	4.4	0	3.4
Teachers	7.1	0	1.1	0	3.1
Friends	3.6	2.9	2.2	0	2.8

As a follow up, students were given options to indicate when they decided towards a science-based programme. This was to determine whether choice of programme in science and technology depends on the level at which the decision was taken. Table 3 reports on the percentage of students' responses. The results from the Table show that the decisions to pursue science-based programmes were made by most respondents (85.0%) before entering Senior High School level. This is not surprising because in Ghana students make programme choices at the Junior High School prior to writing the Basic Education Certificate

Examination (BECE). However, student placement in SHS programmes in Ghana is based on their performance at the BECE examination. This is done to ensure that students who complete Junior High School are placed in schools, which offer the courses of their choice. This to some extent reduces the frustration parents have to go through in seeking admission for their wards when the BECE results are released by the West African Examinations Council (WAEC). The low number of females in science and technology-based careers compared with their male counterparts has been of great concern to the government of Ghana and other stakeholders. As a result the STME clinic for girls was introduced into the the educational system. Participation by females in the STME clinic has always been claimed to be the panacea to increase the number of females in science and technology-based programmes in Ghana.

Table 3. Distribution of students' responses about the level they decided to offer science (%)

School	Engineering (N= 135)	Medicine (N= 75)	Pharmacy (N= 95)	CS/ICT (N= 21)	Total No (N= 326)
Primary	47.4	36.0	32.6	19.0	38.7
Junior High	40.7	48.0	45.3	81.0	46.3
Senior High	8.1	13.3	6.8	0	11.3
After Senior High	3.7	2.7	5.3	0	3.7

The low number of females in science and technology-based careers compared with their male counterparts has been of great concern to the government of Ghana and other stakeholders. As a result the STME clinic for girls was introduced into the the educational system. Participation by females in the STME clinic has always been claimed to be the panacea to increase the number of females in science and technology-based programmes in Ghana. In the light of this students were asked to indicate whether they have participated in the STME clinic or not. Students' responses about their participation in the STME clinic are presented in Table 4. This was to find out the extent to which choice of science and technology programmes was influenced by their participation in the STME clinic. In spite of many claims made about the success of the of the STME clinic for girls, most students (76.8%) in the science and technology-based programmes at KNUST indicated that they had never attended the STME clinics as evidenced from results shown in Table 4.

Table 4. Distribution of students' responses about their participation in the STME clinic (%)

Responses	Engineering (N= 135)	Medicine (N= 75)	Pharmacy (N= 97)	CS/ICT (N= 21)	Total No (N= 328)
Yes	28.4	19.2	20.0	19.0	23.2
No	71.6	80.8	80.0	81.0	76.8

This could mean that only a few schools normally participate in the STME clinic or those who participate in it do not get access to the science and technology programmes under study. Even though, more females than males from different districts participate in the STME programme, majority end up not performing well at the BECE and as a result they are placed in a different programme area altogether.

The third research question looked at the factors which motivated female students in various STU programmes at SHS to pursue their current programmes. The results are presented in

Table 5. Students were given an eight item likert scale on factors that had motivated them in their choice of science and technology-based universty (STU) programmes. They were asked to indicate whether they strongly agree or agree, strongly disagree or disagree or whether they were undecided on certain statements provided in the likert scale using percentage distributions and mean ratings. A mean rating greater than 3.0 indicates that they were motivated by that factor. All negative statements were reversed.

Table 5. Female students mean ratings and percent distribution on factors that motivated them to learn science at the SHS level

No	Statement	SA	A	U	D	SD	Mean	S. Dev
1	Involvement in ST competitions is great fun and use	61.3	34.5	2.7	1.2	0.3	4.6	0.6
2	I was self-motivated to pursue school science	54.3	37.2	4.9	3.0	0.6	4.4	0.8
3	Involvement in science clubs at secondary school is a distraction in doing school science	41.2	53.0	2.4	1.8	1.5	4.3	0.7
4	The status of jobs in ST does not necessarily motivated one to pursue science.	46.3	38.7	10.1	3.0	1.8	4.3	0.9
5	I was encouraged by the respect accorded females in STU programmes.	42.1	47.6	4.3	3.7	2.4	4.2	0.9
6	The personal encouragement given by science teachers propelled me on.	30.8	53.0	5.2	10.7	0.3	4.0	0.9
7	The personal encouragement given by my friends propelled me on.	6.7	17.4	4.6	47.3	24.1	2.4	1.2
8	I was motivated by participating in the STME clinic	4.0	11.3	6.1	46.0	32.6	2.1	1.1

The table shows that majority of students indicated that they were influenced by the following factors: involvement in science and technology competitions was great fun and useful(95.9%);Involvement in science clubs at secondary school is a distraction in doing school science (94.2%); I was self-motivated to pursue school science (91.5%); I was encouraged by the respect accorded females in STU programmes (89.7%); The status of jobs in ST does not necessarily motivated one to pursue science (85.0%); and The personal encouragement given by science teachers propelled me on (83,8%).This may suggest that a student's involvement in science and technology competitions at the Senior High School (SHS) has the tendency to motivate choice of STU programmes. This is because most SHSs organise internal science and technology competitions to select students to participate in the preliminary stages for qualification to the National Science and Mathematics Quiz for Senior High Schools. The introduction of the National Science and Mathematics Quiz for Senior High Schools by the government of Ghana was an intervention to enhance students' participation in science and technology-based programmes. The response shows that most students who took part in the survey might have participated in the science quizzes organised in their schools or by the Ghana Education Service (GES) in the District, Regional or National level.

The responses of female students on self-motivation to pursue science and technology-based programmes were also noted. Self-motivation usually arises from the interest one has in a particular field of endeavour. Thus personal interest contributes to the motivation students have in choosing a programme in science and technology since students tend to be motivated in such circumstances. This is not surprising because very high proportion of respondents indicated in Tables 1 and 2 that they were self motivated to study science at SHS and science and technology-based programmes at KNUST respectively. Similarly, involvement in science clubs at secondary school may help students develop the passion and interest for science, which goes a long way to influence their choice of career in science and technology. This is because students in the science clubs are normally given opportunity to go on field trips to places of scientific interest or listen to presentations from scientists and technologists of high repute as part of the club's programme for the term. In such situations students are motivated to pursue such fields of endeavour.

The mean ratings of students on the six factors mentioned earlier were high indicating that students were influenced by those factors to pursue science and technology-based programmes.Surprisingly, students were not influenced by the following factors: The personal encouragement given by my friends propelled me on (71.4%) and I was motivated by participating in the STME clinic (78.6%).Even though [15,1] have observed that the STME clinic has claimed greater success by improving science and technology studies and encouraging greater participation of women in science and technology programmes, the findings in Table 5 show that this was not the case with respondents in this study.

Research question four focused on how female students in various STU programmes differ in their motivation to learn science while at SHS. The results are presented in Table 6. Mean responses of students for statements on motivation were found for engineering, medicine, pharmacy and CS/ICT programmes. This was to find out the extent to which responses of students of the four programmes differed on the eight statements.

The table shows that the mean ratings of students of all four programmes for each statement were similar except for statement 8. Apart form CS/ICT students who had a mean rating of 3.5, that of medicine, pharmacy and engineering were less than 3.0. This may suggest that majority of CS/ICT students used in this study might have taken part in the STME clinic compared with students in the other science and technology-based programmes. In Ghana, during the District and Regional clinics, participating students are camped for about three weeks and given specific training in the natural and physical sciences as well as in ICT to enhance their hands-on skills and confidence among others. In fact, access to computer training is an integral part of the programme.

It is therefore not surprising that CS/ICT students indicated that they were motivated by their participation in the STME programme. This is in line with research findings by [19] who indicated in her article entitled 'Getting Girls Interested in Computer Science', that increasing girls' computer use may be necessary to increase girls' interest in computer science and hence their participation. Thus when females are given the opportunity to use computers it enhances their chances of participating in computer science at the University level. This is because they gain the necessary confidence required to handle computer applications just like their male counterparts.

Table 6. Mean distribution of female students' ratings of motivation to learn science while at the SHS level

No	Statement	Enginering	Medicine	Pharmacy	CS/ICT	ALL
1	Involvement in ST competitions is great fun and use	4.3	4.3	4.3	4.3	4.3
2	I was self-motivated to pursue school science	4.3	4.5	4.0	4.2	4.3
3	Involvement in science clubs at secondary school is a distraction in doing school science	4.0	4.1	3.9	4.1	4.0
4	The status of jobs in ST does not necessarily motivated one to pursue science.	3.9	3.7	3.6	3.9	3.7
5	I was encouraged by the respect accorded females in STU programmes.	3.9	3.7	3.5	3.0	3.7
6	The personal encouragement given by science teachers propelled me on.	3.8	3.4	3.5	3.5	3.6
7	The personal encouragement given by my friends propelled me on.	3.7	3.1	3.1	3.6	3.4
8	I was motivated by participating in the STME clinic	2.5	2.3	2.4	3.5*	2.5

3.2 Comparison of Students' Motivation to Pursue STU Programmes

The hypothesis states that there is no significant difference in motivation among female students to learn science at SHS level and to pursue STU programmes. The results are presented in Table 7. Table 7 presents the total mean and total standard deviation on motivation, for engineering, medicine, pharmacy and CS/ICT students.

Table 7. Overall mean and standard deviation distributions of female students' ratings of motivation to learn science while at SHS

Programme	Number (N)	Total Mean	Total S. Dev
Engineering	135	26.73	3.86
Medicine	75	25.79	4.21
Pharmacy	97	24.63	3.97
CS/ICT	21	27.43	3.99
Total	328	25.93	4.08

To test this hypothesis, the type of science and technology programme as independent variable was examined for each of the statements on motivation using one-way analysis of variance (ANOVA) to determine whether there were significant differences between female

students pursuing engineering, medicine, pharmacy and CS/ICT at the university level on motivation. The total mean on motivation for all responses of students in each of the four programmes was calculated. This was to help bring out the overall differences between the groups. The table shows that female students pursuing computer science (M=27.4, SD=3.99) had greater mean than female students pursuing engineering (M=26.7, SD=3.86), Medicine (M=25.8, SD=4.21) and pharmacy (M=24.6, SD=3.97) respectively.

A one-way between groups analysis of variance (ANOVA) was conducted to find out whether there were significant differences in motivation among the four groups of female students. The results of the ANOVA on final year female science and technology-based students' motivation are presented in Table 8. The independent variable was type of science & technology porgramme whereas the dependent variable was students' motivation to pursue the selected Science and Technology-based programmes at KNUST.

From Table 8, there was significant difference at the P = .05 level on students' motivation for the four selected Science and Technology-based programmes [F (3, 324) = 6.3, *P*< .001]. This implies that students pursuing the four programmes have differences in their motivation to learn science while at the SHS level and hence their motivation to pursue STU programmes. This is because students learning science while at the SHS level go through programmes and activities (such as field trips and invitation of role models) that have some link with a particular STU programme. As a result they develop interest based on such programmes and activities and are therefore motivated to pursue such STU programmes. Hence the hypothesis indicating that there is no significant difference between motivation of female students pursuing engineering, medicine, pharmacy and CS/ICT cannot be supported and was therefore rejected.

Table 8. One-way analysis of variance (ANOVA) on female students' motivation to learn science while at SHS

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	300.012	3	100.004	6.310	.001
Within Groups	5134.769	324	15.848		
total	5434.780	327			

**Significant P=0.05, N=135 (ENG); N=75 (MED); N=97 (PHA); N= 21 (CS/ICT)*

The corresponding Post-hoc analysis with type of science and technology-based programme as independent variable was therefore conducted as a follow up test to the ANOVA to evaluate pair-wise differences among the means on motivation for the type of science and technology-based programme. This is also to find out differences in motivation between students pursuing the four science and technology-based programmes. The results are presented in Table 9. The results from Table 9 indicate that the mean of students' responses constituting motivation for engineering students (M=26.7, SD=3.86) was significantly different from pharmacy students (M=24.6, SD=3.97) and in favour of engineering students.This means that engineering students were more motivated to pursue their programme at KNUST than pharmacy students. As a result, engineering and pharmacy students did not rate the motivating factors to learn science in a similar way while at the SHS level. Similarly, the mean of students' responses for pharmacy students (M=24.6, SD=3.97) was significantly different from CS/ICT students (M=27.4, SD=3.99) but in favour of CS/ICT students.

Table 9. Post-hoc analysis on students' motivation as a follow up test to the ANOVA

Programme	Programme	Mean Difference	Std. Error	Sig.
Engineering	Medicine	1.0	0.57	0.466
	Pharmacy	2.1*	0.53	0.001*
	CS/ICT	-0.7	0.93	0.974
Medicine	Pharmacy	1.2	0.61	0.307
	CS/ICT	-1.6	0.98	0.452
Pharmacy	CS/ICT	-2.8*	0.96	0.022*

** The mean difference is significant at the P=.05*

This means that computer science students were more motivated than pharmacy students to learn science while at the SHS level. Pharmacy and computer science students also do not have similar motivation in the choice of science and technology-based programmes. However, Medical students (M=25.8, SD=4.2) did not differ significantly from engineering students (M=26.7, SD=3.86), pharmacy students (M=24.6, SD=3.97) or CS/ICT students (M=27.4, SD=3.99). Since medical students are not significantly different from the others, it means that medical students have similar motivation as engineering, pharmacy and computer science students while learning science at the SHS level. Thus from the results of the study one may infer that students in the four STU programmes programmes differed but this inference is based on their perceptions and data collected a few years later.

5. CONCLUSION

The study showed that students pursuing the four STU programmes were self-motivated on their choice of science at the SHS. The other group of people who encouraged them on their choice of science at the SHS were their fathers and both parents but rarely teachers, mothers, siblings and relatives. The study also revealed that generally female students were self-motivated to study STU programmes at the university level. Other people who motivated them on their choice of science and technology-based courses at KNUST include fathers and both parents but rarely mothers, siblings, teachers and friends. The students indicated that they had that inner motivation to pursue their programmes because they had interest in those programmes. The students claimed the interest generated in STU programmes was as a result of the scientific materials they had at home such as computers, science fiction movies and scientific toys.

It was also found in this study that more than one factor motivated female students to pursue STU programmes at the university level. The most influential factors which positively influenced female students' choice of STU programmes among engineering, medical, pharmacy and CS/ICT students were as follows: involvement in science and technology competitions was great fun and useful; involvement in science clubs at secondary school; self-motivation to pursue school science; encouraged by the respect accorded females in STU programmes; the status of jobs in ST careers; and the personal encouragement given by science teachers.This may suggest that a student's involvement in science and technology competitions at the Senior High School (SHS) has the tendency to motivate choice of STU programmes.Similarly, involvement in science clubs at secondary school may help students develop the passion and interest for science, which goes a long way to influence their choice of career in science and technology.

In spite of the success claimed by the STME Clinic for increasing the number of females in science and technology-based programmes it was observed in this study that this was not

the case. The study rather indicated that CS/ICT students used might have taken part in the STME clinic compared with students in the other STU programmes, even though this was minimal. This is because during the District and Regional clinics, participating students are camped for about three weeks to enhance their hands-on skills among others. Access to computer training is an integral part of the programme.

The study also revealed that there was significant difference in motivation among STU students pursuing engineering and pharmacy, and pharmacy and CS/ICT. However there was no significant difference in motivation among STU students pursuing medicine and the other programmes. Majority of the respondents appear not to have been influenced to pursue STU programmes by participating in the STME clinic. It was concluded that female students in various STU programmes at the university level are motivated by different factors.

The findings of the study were limited to engineering, medicine, pharmacy and CS/ICT programmes as well as variables investigated. Also, only final year female students were used in the study, and that other year groups may have different motivation. It is possible that other science and technology-based programmes could also be influenced by different factors. The survey did not include any investigation of the schools from which survey participants originated. This omission prevented considerations of the influences upon students who may have attended well endowed or less endowed schools on their choice of STU programmes. The others are the limited time available for carrying out the research and financial constraints. The study also used female students pursing engineering, medicine, and pharmacy and computer science/ICT.

One other limitation of this study is the comparison of the findings to other researchers' findings whose data are coming from western countries. Ghana is a developing country and the education context varies and even the societies are totally different. The curricula may have different foci as well.

Future research should utilize an in-depth qualitative approach in order to identify other factors that may influence the career decision-making process of female students pursuing STU programmes. Future researchers should also make efforts to extend the study's scope to other STU programmes that could be categorized as gender-dominated occupations.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX

Questionnaire on "Differences among Female Students in Science and Technology-Based University Programmes In Their Motivation To Learning Science"

This questionnaire is being used to gather information on "differences among female students in science and technology-based university programmes in their motivation in learning science". Kindly complete all the items in the questionnaire as frankly as possible. The responses will be used for research purposes only. The information is being collected as part of a Master's Thesis work, and it is therefore strictly for academic purposes. I will be grateful to have you take part in the study by responding to the items as honestly as possible. Please be assured that the information you provide will be kept confidential. Thank you.

SECTION A

Personal Data and Background Information

Personal Data: Please make a tick (√) where appropriate or provide an appropriate response, where indicated.

i. Age: ……

ii. Which type of Senior Secondary School did you attend?
   a) Mixed School [ ] b) Girls School [ ]

iii. Indicate your 'A' Level/SSSCE results in the following subjects.
   a) Physics [ ] c) Chemistry [ ]
   b) Biology [ ] d) Mathematics (Elective) [ ]

iv. Which programme are you offering at the University?
   a) Engineering [ ] c) Medicine [ ]
   b) Pharmacy [ ] d) Computer Science/ ICT [ ]

Background Information: Please make a tick (√) where appropriate or provide an appropriate response, where indicated.

1. Who encouraged you to offer science at SHS? .....
2. Who motivated you to offer science-based course at KNUST?
3. What is your father's occupation? .....
4. What is your mother's occupation? .....
5. Do you have brothers or sisters who are in Science and Technology–based occupations? Yes [ ] No[ ]

If yes, list their occupations:

a) ……
b) ……...
c) ……
d) ……
e) ……

6. When did you decide towards a science-based career?
   a) Primary School [ ]
   b) Junior High School [ ]
   c) Senior High School [ ]

d) After Senior High School [ ]

7. Have you ever participated in the Science, Technology and Mathematics Education (STME) clinic for girls? Yes [ ] No [ ]

SECTION B

Female Students' Motivation to Pursue Science and Technology-Based Programmes

This section contains statements about what motivated female students to pursue science and technology-based programmes. The statements are both discouraging and encouraging influences on female students pursuing science and technology-based programmes. Use the scale provided to indicate your responses to the items below.

Make a tick [√] on the scale that best describes your response.

SCALE: STRONGLY AGREE - SA
AGREE - A
UNDECIDED - U
DISAGREE - D
STRONGLY DISAGREE – SD

No	Statements	SA	A	U	D	SD
8	Involvement in science and technology competitions is great fun and useful					
9	I was self-motivated to pursue school science					
10	Involvement in science clubs at secondary school is a distraction in doing school science					
11	The status of jobs in science and technology does not necessarily motivated one to pursue science					
12	I was encouraged by the respect accorded females in science and technology-based university programmes					
13	The personal encouragement given by science teachers propelled me on.					
14	The personal encouragement given by my friends propelled me on.					
15	I was motivated by participating in the STME programme.					

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history.php?iid=289&id=21&aid=2322