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**Senior High School Female Students' Interest in Physics as a
Course of Study at the University Level in Ghana**

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Abstract

The study of females' interest in physics is an issue of international concern. Of the sciences, physics is the subject in which the increase in the number of females involved has been particularly low. The term 'interest' may usually refer to preference to engage in some types of activities rather than others. This study investigated whether Ghanaian Senior High School female science students would prefer to study physics at the university or not and the reasons for their choice. Two hundred and one final year female students in four Senior High Schools offering biology, chemistry and physics in the Cape Coast Metropolis of the Central Region of Ghana, participated in the study. Data was obtained with Questionnaire on Female Participation in Physics and Interview Protocol, administered to the female students. The findings from the study suggest that female students do not prefer physics as a course of study at the university level due to limited career opportunities in the subject. An implication from this study is that female enrolment in physics will not improve unless information about career awareness in the subject is made available to students. Serious efforts must be made by physics educators as well as Physics Departments to create awareness of career opportunities in the study of physics.

Introduction

Physics plays a key role in understanding the world we live in, and physicists contribute strongly to the welfare and economic development of nations. The knowledge and problem-solving skills of physicists are essential in many professions and industries and to

society at large. To thrive in today's fast-changing, technological world, every country must achieve a highly educated population in physics, fully engaged in making decisions important to their well being (International Union of Pure and Applied Physics [IUPAP], 2002). Also, knowledge of physics is an important part of general literacy for every citizen.

However, professional studies of engineering, architecture, astronomy and physics are dramatically underrepresented by females (Donnellan, 2003). While females represent over half the general population worldwide, they represent only a tiny minority of professionals in physics with majority going into biology. History has it that this imbalance was thought to be the result of differing brain structures and functions (Baird, 1996). However, explanations based on gender-specific socialization have largely displaced the brain difference model. Theories of Socialization hold that females are directed away from physics studies/courses by parents, teachers, and peers (male and female) because such studies are considered to be unfeminine (Baird, 1996). Such theories as reported by Baird further argue that females themselves select out of physics courses because the careers involved in those fields do not match the careers with which girls are encouraged to be concerned.

The literature shows that high school and college teachers are generally aware of low female participation in physics courses and the growth of this low participation at higher levels of study (Baird, 1997; Laura, 2005). According to Baird (1997), high school and college teachers assign a number of reasons to low female participation in physics courses. Among them are:

- (a) Societal and cultural influences
- (b) Lack of female role models
- (c) The "Old Boys Club" aspect of physics
- (d) Discouragement from parents, counselors and teachers
- (e) Lack of interest in physics
- (f) Lack of confidence in physics
- (g) Aptitude, ability or brain differences

A study conducted by Laura (2006) on "Why Are There So Few Female Physicists" identified some of the problems specific to females in the study of physics. According to Laura, many female students do not receive the same level of mathematics instruction as their male peers, and thus do not have the same foundation to study physics. She stresses that girls are not identified for their abilities in mathematics and science in the same proportion as boys.

Donnellan (2003) has observed that the number of females taking science programs, particularly physics at the higher education level is low. Although, more females take biology, far fewer take physics. Physics in particular, is the least successful of all the sciences in attracting and retaining females within the field (Hazari & Potvin, 2005). IUPAP (2002) observed that at the higher educational level, few females choose to enroll in most science courses, both at undergraduate and postgraduate level and among these females who choose to enroll in science courses only a handful choose to study physics. In Ghana for example, at the Kwame Nkrumah University of Science and Technology (KNUST), female enrolment figures in physics, chemistry and biology reveal a low trend of female participation in physics. In 2004 out of a total of 109 female students who were admitted into physics, chemistry and biology, 12 (11%) of them offered physics while 36 (33%) offered chemistry and 61 (56%) offered biology. In 2005 the physics class of KNUST comprised 12 (14%) female students as compared to 28 (33%) and 46 (53%) female students who pursued chemistry and biology programmes respectively. Furthermore, out of a total of 75 female students who were admitted into physics, chemistry and biology at KNUST in 2006, only 8 (11%) pursued physics programme while 37 (49%) pursued chemistry and 30 (40%) pursued biology programmes. Again in 2007 only 10 (13%) female students enrolled in the physics class whereas there were 39 (51%) in chemistry and 27 (36%) in the biology. Moreover, since the inception of KNUST, from 1960 to 2008, out of 804 physics graduates who have passed through the university only 67 representing 8.3% were females (College of Science Handbook, 2008).

Female enrolment figures in physics, chemistry and biology at University of Cape Coast (UCC) also reveal a low trend of female participation in physics. Basic statistics produced by the Student Record and Information Management Unit (SRIMU) on females' participation in physics for 2005 to 2008 show that in 2005 out of a total of 171 females who were admitted into the science programmes only 10 (7%) pursued physics to the final year. The remaining 160 pursued chemistry, biology or mathematics. In 2006, only 6 (4%) out of 135 females offered physics at the final year while in 2007, 11 (7%) females out of a total of 157 pursued physics at the final year. In 2008, out of a total of 143 females who read physics in the first and second years only 13 (9%) females pursued physics at the final year. In all cases majority of the female students pursued biology followed by chemistry and mathematics in that order.

Simpson, Koballa, Oliver, and Crawley (1994) published an extensive review about students' attitudes toward different subjects. Normally, a negative attitude towards a subject leads to a lack of interest and, when the subject can be selected, as it is in our universities in Ghana, the likelihood of students avoiding the subject is higher. This study therefore sought an answer to the question: What accounts for Senior High School (SHS) female students' preference for physics as a course of study at the university level?

Methods

Four Senior High Schools (SHS) were purposively selected from ten SHS in the Cape Coast Metropolis for the study. The selection of these schools was influenced by the purpose of the study. The schools consisted of two single sex female schools and two co-educational (mixed) schools. These schools were the only SHS in Cape Coast Metropolis that had female enrolment and also doing all the three elective science subjects (biology, chemistry and physics). Final year female science students were used as the sample for the study because they already have had three years of teaching from their tutors of all the three elective science subjects. In each of the co-educational schools all the final year female science students were sampled and used. A total of 60 female students were obtained from these two schools, 35 from school A and 25 from school B. In the case of the two female schools, computer generated random numbers was used to select 83 and 58 final year science students according to the number of the final year science students in each school, making a total of 141 students from the two female institutions. A total sample size of 201 SHS female science students was used for the study. The mean age of the students was 17 years with a standard deviation of 0.7 respectively.

The instruments developed for the study were: questionnaire on low female participation in physics (QLFPP) and interview protocol for female students (IPFS). The QLFPP was in two parts. The first part consisted of open-ended items which elicited respondents' opinions on participation of females in physics studies. The second part, closed-ended items with five-point Likert scale, asked respondents to indicate the extent to which they agree to some general views of students about physics. Semi-structured interview protocol was also designed for the female students. The semi-structured interview was used as follow up to gather data in the female students' own words in order to delve deeper into some of the issues that came up from the questionnaire.

Data collection was done in two stages. In the first stage, a questionnaire was administered to the SHS final year female science students to find out whether they would choose to study physics at the university or not and the reasons for their choice. The second data collection was a follow up on some issues that came up from the analysis of the first fieldwork data. Thus, the second stage involved individual student interviews with a smaller number of the females to delve deeper into some of the issues that came up from the questionnaire. The second data collected gave the researcher additional insights into the survey findings conducted in the first fieldwork.

Results and Discussion

Prior to giving their responses on female participation in physics, 201 SHS female students used for the study were asked to indicate the programme they would like to pursue at the university. Table 1 shows the first choice programme of preference of these females. As indicated in Table 1, physics was the least chosen option while medicine, pharmacy and nursing assumed prominence. Two-thirds of the SHS females (67.2%) would like to pursue medicine as their first choice programme at the university, followed by pharmacy (6.0%) and nursing (5.5%). Only 1.5% of SHS female final year students would like to pursue physics as their first choice programme. Programmes that had less than three frequency counts were categorized as others. These included Psychology, Statistics, Information Technology, Marine Engineering etc. When the students were made to indicate their second and third choice programmes in case they missed their first choice programmes, physics was still given a low profile.

Table 1: First Choice Programme of Preference of SHS Female Final Year Science Students

Programme	No	Percentage
Agricultural Science	5	2.5
Biological Science	6	3.0
Chemistry	4	2.0
Medicine	135	67.2
Nursing	11	5.5
Pharmacy	12	6.0
Physics	3	1.5
Yet to decide	5	2.5
Others	20	10.0
Total	201	100.0

When students were asked to choose between biology, chemistry and physics as a course of study at the university, physics was again the least chosen subject. Majority of the SHS female

students (82.6%) indicated they would not like to offer physics at the university as shown in Table 2.

Table 2: Proportion of SHS Female Students who would choose to offer Physics at the University instead of Biology or Chemistry (N = 201)

Programme	No	Percentage
Biology	119	59.2
Chemistry	47	23.4
Physics	35	17.4
Total	201	100.0

These results indicate that female science students at the SHS level in the Cape Coast Metropolis had much interest in biology and chemistry and their related course than physics. The SHS female respondents however cited abstract nature of physics, limited career opportunities in physics, poor performance due to difficulty of the subject and mathematics aspect of physics as reasons why they would not like to pursue physics at the university. It can be seen from Table 3 that the main reasons why SHS female students do not like to pursue physics at the university have to do with limited career opportunities in physics (43.4%) and difficulty of the subject (27.7%). Mathematics component of physics was also a discouraging factor to the females from pursuing further studies in physics at higher institutions. Abstract nature of physics did not matter to most of the students.

Table 3: Reason offered by SHS Female Students who would not want to Pursue Physics as a Course of Study at the University (N = 166)

Category	No.	%
Limited career opportunities in physics	72	43.4
Difficulty of physics	46	27.7
Mathematics factor	32	19.3
Abstract nature of physics	16	9.6

SHS female students who were later interviewed stated that physics was not related to the fields they aspire to pursue. They also believed that there were no job opportunities for physics students after graduation, apart from teaching. One female student responded:

Most people I had known as physics students in the universities came out as teachers. I do not want to limit myself to teaching (SHS female student, mixed school).

Another also responded:

I simply don't like physics; it has no future for me. Besides,

I don't want to find myself in the classroom (SHS female student, single sex school).

The SHS female students also reported that among the three subjects (biology, chemistry and physics) physics was the most difficult one. They all spoke the same language that biology and chemistry were much easier to understand compared to physics. This according to them confirmed what they had been hearing from people, friends and even teachers that physics was difficult at the university. Some of them were simply convinced that what they were going through at the SHS level clearly demonstrated the nature of physics at the university. They therefore preferred not to enter into this "hell" again. One female responded:

Physics at the SHS level is too complicated, difficult and bulky. I would not have to go through this again at the university (SHS female student, single sex school).

Another also offered:

Physics at this level (SHS) is really difficult for me hence I really don't know how I am going to cope with it at the university (SHS female student, single sex school).

Another reason for SHS female students not interested in physics at higher levels had to do with the mathematics component of physics. Almost all the females who were interviewed mentioned that physics involved a lot of calculations (mathematics) and formulas which made the study of the subject more difficult. Female SHS students who expressed this sentiment shared a similar view that biology was a reading subject and that they preferred reading to calculations. It was clear in their statements and comments during the interviews that to pursue physics in the university, one needs to have a good background in mathematics because according to them, what they were going through at the SHS level was a clear demonstration of what physics would be at higher levels especially at the university.

The 16 (9.6%) females who would not like to offer physics because they described the subject as abstract, further explained that it required one lot of time to think in order to remember as many assumptions and principles as far as possible, and making deductions. This according to them made physics boring to study. One female student from a single sex school complained:

The theories, principles, laws and formulas are too many to be memorized. Everything seems to be an assumption and that studying it confuses me as I try to compare it to reality.

In summary the study was aimed at finding out reasons which accounts for SHS female students' choice of physics as a course of study at the university. When students were asked to indicate the programme they would like to pursue at the university, physics was the least chosen option while medicine, pharmacy and nursing assumed prominence. When the students were made to indicate their second choice programmes in case they missed their first choice programmes, physics was still given a low profile.

The respondents gave such reasons as physics is abstract, there are limited career opportunities in the subject, poor performance due to the difficulty level of the subject and that the subject has a mathematics component. The SHS female students observed that their experiences in the physics class have confirmed the stories they have heard from their friends and teachers about how difficult physics is at the university. Hence, they will not like to enter what they called "hell" by going in for physics. They however suggested among other things that if they get good tuition from their teachers and also made known about career opportunities in physics, they will be encouraged to pursue the subject beyond SHS level.

The findings also suggest that the content of physics is more difficult to majority of female students compared to biology and chemistry. The findings from this study confirm most of the findings in the literature (Bhatia, 1991, Baird 1997, Zietsman & Naidoo, 1997, National Science Foundation [NSF], 2002, Ivie & Guo, 2005). NSF for example reported that the culture of physics is harder for females to break into than that of other sciences. Bhatia has commented that most girls hesitate to go in for physics, as this makes heavy demands, both in matters of time and effort because of the mathematics and this deprives them of other interests and activities. Ivie and Guo asserted that student (both genders) suffer from the unpredictability in an academic physics career.

Educational Implications and Recommendations

The findings from this study suggest that SHS female students are not interested in physics as a course of study at the university level. The student lack of interest in pursuing further course in physics may however be attributed to a number of reasons. In the first place, the perception that, limited career opportunities in physics, play an important role in female students' preferences for biology and

chemistry courses suggest that little is known by female students about career opportunities in physics. It can be inferred from the responses that female science students seem to know more about job avenues in biology and chemistry than physics. It is quite unfortunate that for many female students the only job physics offers is teaching which many female students do not want to associate themselves with. Efforts must therefore be made by physics teachers as well as the various physics departments to create awareness of career opportunities in physics so as to make the subject more appealing to female students. Medical physics should also be stressed upon because most females believe that biology and chemistry are the only subjects that can lead them to the health sector where most females are interested to work.

Again, it looks like students are not made to appreciate the relationship between mathematics and physics at SHS. There is no doubt about it that physics is mathematics based at higher levels, weak background in mathematics therefore makes the subject more difficult to study/learn at these level. Physics teachers at SHS must therefore take their time to explain the mathematics aspect of the subject for students to appreciate it, especially female students who are believed to be scared of mathematics. Female students' interest in physics can be enhanced if proper foundation in the subject is ensured by carefully examining the way physics is taught at the SHS level.

Recommendation for further study

In order to ensure good foundation in the subject, further studies can be conducted to examine the way physics is taught at SHS levels.

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