Students’ interest in physics by gender, school type and programme of study

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***Abstract*: Studies in Ghana and globally have reported a dwindling in students’ interest in pursuing higher degrees in physics and physics related programmes. Thus, the purpose of this study was to investigate students’ interest in physics according to gender, type of school and programme of study. The overarching design employed in this study was the cross-sectional survey design. The population of this study was made up of all Form three students who offered physics as elective in public senior high schools (SHS) in the Eastern region of Ghana. In this survey, a questionnaire-Srudents’ Interest in Physics (SIP), was used to gather information about students’ interest in physics from 415 physics students, comprising of 161 females and 254 males sampled randomly from 14 schools (comprising Boys only, Girls only and Mixed Sex Schools) in the Eastern region of Ghana, about their interest in physics. The sample was taken from different gender, school type (Boys only, Girls only and Mixed) and programmes (General science, Agricultural science and Technical) using a multistage sampling technique. It was found that students’ interest in physics was generally moderate. Male students were found to be more interested in physics than female students. Similarly, Technical students were more interested in physics than General Science students whereas students from Boys’ only schools were found to have higher interest in physics than students from mixed and Girls schools.**

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I. INTRODUCTION

Background

Physics is accepted widely as the most central among the sciences and forms the basis for the present technological world. It is so because many of the world’s development existing today have come about as a result of research in physics (Kiruki & Orodho, 2015). Looking at how crucial physics is to the technological advancement of a nation and to the building of the economy, one would have expected that it will attract the attention of many students and get them to develop interest in the subject at school, pursue it further to the tertiary level, and develop a greater willingness to work in a field that involves physics. However, the available literature paints a gloomy picture of students’ interest in the study of physics (Buabeng, Ossei-Anto & Ampiah, 2014; Oon & Subramaniam, 2013; Adeyemo, 2010). Studying students’ interest in a subject is important since interest influence subject achievement and career choice (Mabee, Haruna & Salifu, 2021; Harackiewicz & Hulleman, 2015).

Ghanaian students are introduced to concepts in physics compulsorily through integrated science at the Basic school as part of the attempt to produce scientifically literate citizenry (NACCA: MoE, 2019) and also to lay a strong foundation for future courses, programmes and careers in physics. Physics (topics and concepts) forms part of the integrated science curriculum taught at the Junior High School level of the education system of Ghana. As a branch of science, most taught of the concepts taught in physcis are also selected for learning by pupils in the integrated science syllabus for JHS and Senior High Schools (SHS) and can therefore not be exempted from the perceived ‘hatred’ for science (Astrom, 2012; Dobson, 2006; Lyons, 2006; Krogh & Thomsen, 2005). In the integrated science curriculum for basic schools (NaCCA, 2019) include physics related topics such as measurement, basic electronics, electrical energy, light energy, magnetism, sources of energy, conversion and conservation of energy, heat energy, and machines. In addition, the senior high school programme structure has physics as a compulsory elective subject to be taken by students pursuing General science as a programme, and in most schools as optional elective subject for those pursuing Agricultural science and Technical programmes.

Statement of the Problem

Despite the fact that students are introduced to a number of physics related topics studies in Ghana and globally have reported a dwindling level of students’ interest in pursuing higher degrees in physics and physics related programmes (Buabeng and Ntow, 2010; Oon & Subramaniam, 2013). Furthermore, many students have unfavourable perception about the subject. Many students perceive physics to be very difficult (Oon & Subramaniam, 2013; Buabeng and Ntow, 2010; Spall, Stanisstreet, Dickson & Boyes, 2004), highly mathematical, abstract in nature and irrelevant (Mabee, Haruna & Salifu, 2021; Angell, Guttersrud, Henriksen, & Isnes, 2004). There are also issues of curriculum overload (Spall, Stanisstreet, Dickson & Boyes, 2004). All these factors, in one way or another, impacts on students’ interest in physics. Kiruki and Orodho (2015) have also noted in study in Secondary Schools in Kenya that the number of students who pursue science subjects particularly physics has decreased significantly. What then accounts for students’ low interest in physics?

In addition, Ghanaian students’ performance in physics at the Senior High School over the years has been generally and consistently poor WAEC examinations (Buabeng, Ossei-Anto & Ampiah, 2014; Anamuah-Mensah, J., Mereku, D. K. & Ampiah, J. G., 2009). Data collected by the researcher on SHS students' performance in physics between 2014 and 2019 (WAEC, 2020) has proven to be abysmal. In detail, the data show that a good number of the physics candidates failed to obtain a quality grade of A1 – B3 and the general performance has been marginal. The data also show that the general performance for the years under review has always been below average. For example, the mean raw score respectively for theory (out of 60) and practical (out of 50) for 2013 was 24(13); 16(24) for 2014; 19(30) for 2015; 15(29) for 2017 and 26(28) for 2018 (WAEC, 2020). These translate to mean percentage mark of 33.6, 36.4, 44.5, 40 and 49.1 respectively. The case of eastern region is not so different from the national one. The trend in performance for Eastern region was as gloomy as that of the national level (WAEC, 2020). For instance, out of 5306 candidates who sat for the WASSCE physics papers in 2018 only 166 (3.1%) obtained grade A, 195 (3.7%) obtained grade B2 and 19.5% obtained grade B3. In all, 1766 (33.2%) candidates failed to obtain the pass grade of A1 to C6. Similarly, in 2019 only 158 (4.5%) candidates obtained grade A1, 291 (8.2%) obtained Grade B2 and overall failure rate of 24.5%. Additionally, Chief Examiner's Report from WAEC on SHS physics presented a marginal or poor performance of candidates in physics for the years under review (WAEC, 2013; 2014; 2015, 2017, 2018).

Another issue worthy of note is that of women under representation in physics education (Buabeng, Ampiah & Quarcoo-Nelson, 2012; Smith, 2012; Institute of Physics, 2012). Problems of women under-representation and under-achievement in science and mathematics education continue globally and low female enrolments in physics at the tertiary institutions in Ghana persist (Cassidy, Catter, Crawford & Dythan, 2018; Francis, Archer, de Witt, & Yeomans, 2017; ESERA, 2017; Buabeng, Ampiah & Quarcoo-Nelson, 2012). However, gender is one of the broad factors that influence the likelihood of a student becoming interested in a subject (Cassidy, Cattan, Crawford and Dythan, 2018; Darlinton, 2018). According to Cassidy, Cattan, Crawford and Dythan (2018) four times as many boys (17%) as girls (4%) took up physics at 'A' level in UK in the year 2017. In comparism with Chemistry and Biology, Cassidy et al. (2018) reports that the difference between boys (15%) and girls (13%) was only two percetages points in favour boys took up A level Chemistry. Howver, the trend was reversed as 19% girls as against 14% boys took up Biology for the same year. Many researchers have reported gender differences in the achievements of science subjects (Makarova, Aeschlimann & Herzog, 2019; Hyde, 2014). However, the causes of gender differences, according to Hyde (2014) have been explored keenly. In his work about the key factors influencing students' interest in STEM subjects, Cheung (2018) found no difference in interest levels by gender upon interviewing 60 science students in Hong Kong and exploring the findings further using a questionnaire administered to 591 students. However, Makarova, Aeschlimann and Herzog (2019), and Darlington (2018) see some underlying gender differences that triggers interest in the sciences. Generally, not much work has been reported on students' interest in physics from Eastern region of Ghana. The few available works on subject interest also approached it holistically instead of categorizing into components such as school type, programme of study and gender. What is therefore lacking currently is research work that seeks to elucidate the current state of students' interest in physics and how this is related to gender, the school type, and grogramme of study Ghana. It was interesting, therefore, to investigate whether gender, school type and programme of study have any influence on students' interest in physics.

Purpose of the Study

The purpose of this study was to explore the current state of Senior High School students' interest in physics with respect to gender, type of school and programme of study in Eastern Region of Ghana.

Research Questions

The following research questions guided the study:

1. What is the level of students' interest in physics?
2. Is there any statistically significant difference in students' interest in physics by gender, schooltype and programme of study?

II. LITERATURE

Concept of Interest

Interest has been abstracted as a particular association concerning an individual and an activity, object and or topic, which is depicted by positive passionate experiences and feelings of personal importance (Kunter, Baumert & Koller, 2007). This abstraction is based on the person-object approach to interest (Krapp, 2007). Ivowi (2001) sees interest simply as a "state of concern or curiosity". To him interest is what causes a learner to become involved with anything and argues that a person shows interest in something when she/he actively gets involved with that thing, shows concern for or is curious about that thing. The implication is that learners demonstrate interest in physics if they show sufficient concern and curiosity and actively involve themselves in all activities related to the subject. Ivowi enumerates five ways by which learners' manifest interest in physics (as a science) and mathematics.

Firstly, the learner reads a lot of texts about the subject. That is the learner tends to read more about the subject as compared to other subjects. Secondly, the learner exhibits curiosity, evaluation and logicality. These are attributes of a scientist. In addition, the learner is seen to like to manipulate devices as well as data, displays data in different forms and finally, applies related concepts, principles and ideas in many ways (Ivowi, 2001).

Interest is a feeling that prompts one to spontaneous activity and is a powerful dictator and motivator in the learning process (Aggarwal, 2007). The implications are that students will tend to learn, pay attention, remember, imagine and read more readily when their interest or emotions are positively provoked. Oon and Subramaniam (2013) agree that interest is what makes a person prefer one type of activity to another and is closely associated with attitudes, values, and other forms of human preferences (i.e., interest motivates and compels attention). Interest may also be considered as the medium and at the same time a goal of educational processes (Djudin, 2018). A conscious effort, therefore, to stimulate the student's interest is very essential component of education. This is due to the fact that the level of a person's interest influences his/her attention, goals, ability to self-regulate, their study strategies, and levels of learning and achievements (Renninger and Hidi 2016). Students generally will choose physics if they find the subject interesting (Lanoven, Byman, Juuti, Meisalo & Uitto, 2007).

Decline in Students in Interest in physics

According to Djudin (2018), students will learn physics better, and subsequently, choose physics intentionally if they are interested in it. Djudin (2018) also noted that there has been a persistent decline of students' interest in physics over the last two decades in many countries. Issues of lack of interest and unwillingness to pursue further degree in physics appears to be a global phenomenon (Oon and Subramaniam, 2013). Oon and Subramaniam have for instance noted in a study in Singapore (Asian Country) that even though there is a general interest in school physics, most of the students are unwilling to pursue the subject to the tertiary. The study also revealed that majority of the students have a bad image about physics as good number of them perceived physics to be difficult even among those who intend to choose physics related careers. There is overwhelming reported evidence of low interest in school physics in literature (Buabeng, Ossei-Anto & Ampiah, 2014; Oon & Subramaniam, 2013; Adeyemo, 2012; Astrom, 2008; Hongsa-Ngiam, 2006; Killeary & Mitchell, 2015; Lavonen, Byman, Juuti, Meisalo & Uitto, 2005).

This low interest of students in school physics is evidenced in the fact that few students express the willingness to pursue physics, physics related courses and physics related careers after secondary or high school education (Oon & Subramaniam, 2013). Oon and Subramaniam reports that out of a 34% of a sample who expressed interest in choosing physics as their major in university only about 31.5% of that subsample (i.e., 10.5% of the total sample) exhibited clearly that they are most likely to work in a physics-related field when they graduate. This is a worrying phenomenon and puts the future of technology in jeopardy and clearly shows that many physics graduates are using the degree in physics as a means to enter other more appealing professions as noted by Bernstein (2008) who claims that business and financial sector is choked with people who possess degree in physics. There is however a contrary report from Singapore (an Asian country) where Oon and Subramaniam (2013) reports that students have high interest in school physics. A situation which has been attributed to curricular restructuring and more importantly teachers' ingenuity in approach to teaching.

Students' interest factors in physics

On the issue of factors affecting students' interest in physics, Djudin (2018) found both internal and external factors. The internal factors relate to the students' attitude, skills, knowledge, aspirations (hope), assumptions, goals and so on whereas the external factors relate to the environmental conditions including teaching and learning methods utilized by the teacher, family environment, teaching and learning resources, type of school, infrastructure and management practices. An area worthy of discussion is the issue of learners' attitude to physics. Attitude factors include gender, personality traits, curriculum and structural variables. Trumper (2006) as cited in Djudin (2018) identified gender as the most influential factor affecting learners' attitude. In general males are noted to have favourable attitude to science than females which translates into lack of interest in females. Students' variables such as study habit, attitude to and interest have also been identified as better predictors of students' academic performance in physics (Awodun et al., 2014). Others have also listed gender, nationality, contextual interest of physics contents, interest in contents of physics itself, interest and enjoyment in activity type, teaching methods, and level of difficulty as some of the factors which interrelate with physics learning (Lavonen, Byman, Juuti, Meisalo & Uitto, 2005). Weno (2014) also reports a positive and significant relationship between interest in physics and students' ability to solve physics problems and also interest in physics and knowledge of basic concepts in mathematics. Keller, Neumann and Fischer (2017) on the other hand identifies teacher motivation and interest in teaching physics as one of the factors which influence students' interest positively.

There are also a number of factors that lowers learners' interest in physics. Djudin (2018) conducted a literature review of students' interest in physics and found that certain factors are very influential in making students become disinterested in physics. These factors according to Djudin were a) lack of familiarity with physics; b) students regarding physics as the most difficult science; c) over reliance on memorisation; and d) fear of failing the class. Oon and Subramaniam (2013) also conducted a study on the declining interest in physics among students. Their study which used RASCH analysis of data examined views of physics teachers' concerning significant factors contributing to the decrease of interest among physics students. The study used physics instructors numbering 190 selected from 91 secondary schools and nine junior colleges in Singapore using a survey instrument to solicit the views of the teachers. They found that the physics teachers were unsure with regards to the career prospects of and market demand for physics graduates. The teachers were of the view that physics seems very abstract and tough to the students. It was also realized that the notion that physics is for boys appears to be well entrenched in society. The teachers therefore recommended the utilisation of laboratory work and other co-curricular activities to improve students' interest in studying physics.

Factors influencing the take-up of physics

Oon and Subramaniam (2013) conducted a study in Singapore to investigate what influences Singaporean students to either pursue or discontinue the study of physics and related careers. The study revealed a surprisingly high interest in school physics even among students who did not intend to take up physics as a major in the university. This finding is particularly surprising because the literature especially from the western world and Africa portrays physics as less interesting among students (Williams, Stannistreet, Spall, Boyes & Dickson, 2003). In general, the students' interest in physics appeared to have been influenced by their perceived utilitarian value of physics as they perceive physics to have favourable career opportunities and it is also important for a nation to progress in technology (Oon & Subramaniam, 2013). This orientation is missing in other places. Other factors such as laboratory work, enrichment activities and physics textbooks have also been found to boost students' likeness for physics.

Another factor that influences students' interest is the social influence from parents and peers (Lyon, 2006). It was also found that the students' interest in physics is negatively influenced by their peers and parents who have somewhat unfavourable perception about the subject and rather tend to discourage them from taking up physics as a major (Oon & R. Subramaniam, 2013). In addition to peer and parental influence other factors found to adversely affect the take up of physics include the perceived difficulty of the subject, perceived less relevance of physics as compared to other subjects such as chemistry and biology which are highly perceived to have the potential of solving environmental as well as medical problems (Spall, Barrett, Stannisstreet, Dickson & Boyes, 2003) and perceived low status or remuneration of physics graduates (Woolnough, 1993). However, a more recent study from Singapore has disproved this notion. Students in Singapore perceived that physics is more relevant especially in modern technological advancement and that a qualification in physics opens up more career options (Oon & Subramaniam, 2013; Lyon, 2006). One factor that has the possibility of either influencing students' interest negatively or positively is the teacher. Oon & Subramaniam (2013) also found that physics teachers can foster or influence students' interest in the subject. This will depend on the kind of management practices and teaching methodology employed by the teachers in the classroom (Kunter, Baumert, and Koller, 2007).

Gender differences in physics interest

Gender is one of the broad factors that influence the likelihood of a student becoming interested in a subject (Darlington, 2017). Many researchers have reported gender differences in the achievements of science subjects (Hyde, 2014). However, the causes of gender differences, according to Hyde (2014) have been explored keenly. In his work Cheung (2018) found no difference in interest levels by gender upon interviewing 60 students in Hong Kong. However, Ainley, Hillman and Hidi (2002) and Darlington (2017) see some underlying gender differences that triggers interest. It is recommended that since there exists gender bias against girls in science there must be conscious effort on the part of teachers to enhance girls' engagement, performance and interest. Also, attention must be given to the wide ability ranges that exist between boys and girls and carefully provided for (Ivowi, 2001).

Intention to Reengage

Intention to act is a favourable response or positive affect towards a given object (Ainley & Ainley, 2011). It is perceived that knowledge (having knowledge in physics), affect (enjoying physics) and value (valuing physics) will individually and coherently predict learners' general interest in physics and subsequently predict both current and future engagement with the subject. In the context of this study learners' interest is measured along their current engagement with physics in classroom and their intention to pursue physics related disciplines and careers and also their engagement with physics outside of school setting.

Conceptual Framework

Interest is viewed as content specific and relational in this study. This implies that a person cannot simply have an interest unless interested in something specific called the object of interest (Hasni & Potvin, 2015). The object of interest in this study is physics. Previous studies (Buabeng, Ossei-Anto &Ampiah, 2014; Buabeng & Ntow, 2010) on interest among students have sought to measure a general interest combining all dimensions without analyzing the individual dimensions and making generic conclusions as to students having low interest in the subject or not. However, studies have shown for instance that it is possible for students not to be interested in furthering their education in a particular subject but demonstrate a high interest in the subject whiles still at school (Hasni & Potvin, 2015; Oon & Subramaniam, 2013). Some students are interested in the subject they study in school for different reasons including the teacher personality and methods, self-efficacy, prior knowledge, achievements and so on. These students, however may not engage with the subject outside school for instance when at home. On the other hand, the interest of some students in a subject may extend beyond the school setting to the activities they engage in at home (outside school setting) whereas others extend their interest to a willingness to take up a career in the subject area. It is therefore expedient that when measuring the interest of students in a subject such as physics, all the three aforementioned dimensions are taken into consideration as has been done in this study.

In this study, students' interest in physics is, therefore, studied along three dimensions: a) foundational physics interest b) general school physics interest and c) career and future studies interest (desire to reengage). These three dimensions constituted a combined interest measure referred to as student interest in physics (TSIP) scale (Fig. 1)

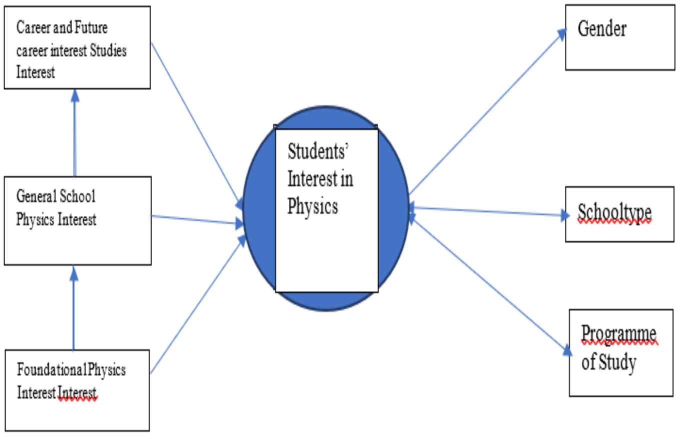

Figure 1: Concptual Framework of Students' Interest in Physics

Foundational physics interest describes students' interest developed in the subject as a result of their initial engagement with the subject matter and usually stimulated by conditions of and stimuli from the environment. This may be due to initial novel situation presented by a teacher through authentic problems, puzzles, surprises, and or unexpected phenomena (Hidi & Renninger, 2002). General school physics interest, on the other hand, describes a higher level of students' interest which propels them to study and engage, more often, with the physics taught in school. The student may have this interest and yet may not want to take up a career in physics or study physics in the University. Finally, Career and future study interest describes students' interest that makes them become willing to pursue physics even after their current level of studies, such as from Senior High School to the University. The student with this kind of interest may also wish to take up a physics-related career. Both 'General school physics interest' and 'Career and future study interest' are contingent on students' 'foundational physics interest'.

In Figure 1, it is explained that gender, school-type and programme of study are some of the factors expected to influence and predict students' interest in physics: that is, students' foundational interest in physics, current engagement with school physics; and future engagement with physics. Hence, students' interest in physics is studied firstly along their foundational physics interest, general school physics interest and career and future studies interest and finally, with respect to their gender, school-type and programme of study.

III. METHODOLOGY

The study was aimed at investigating the state of students' interest in physics with respect to gender, school type and programme of study. The cross-sectional survey design was therefore employed since the aim of the study was to collect information on senior high school students' interest in physics (Creswell, 2012).

Sample and Sampling Procedure

The population of this study was made up of all Form three students who offer physics as elective in public Senior High Schools (SHS) in the Eastern region of Ghana. Eastern Region was chosen out of convenience due to COVID 19 restrictions at the time of data collection. Form three students were used because at the time of data collection, they had interacted more with the contents in physics curriculum and the teachers so as to develop interest in the subject or otherwise. The Eastern region had 59 SHSs which offered physics as an elective subject at the time of data collection. Physics was a compulsory subject for all General Science students. Technical and Agriculture students have the option of choosing physics as one of their electives. It is possible to find in one school both the technical or Agriculture and General Science physics classes.

Multistage sampling technique was used to select students from 14 Schools selected to participate in this study. To arrive at the number of schools used for this study, firstly, the researcher used a criterion of schools that have had physics teachers who have consistently taught students in the schools for five years. After the implementation of this criteria, 25 schools were eligible for this study. Secondly, a criterion of students who had been with their current physics teachers for more than two consecutive years were also used to select 14 schools. These criteria were based on the focus of the study which was development of interest. The teachers needed to be experienced and be with their students for long in order to develop interest of studying physics in them.

The distribution of the 14 schools was such that two were boys only, two were girls only and 10 were mixed schools. The 14 schools randomly selected for this study had students who offer physics as elective in three different programmes (i.e., General science (95%), Agriculture (2.6%), and Technical (2.4%)). Since programme of study was one of the variables under study, the distribution of this variable needs to be clearly pointed out. The two boys-only and girls-only schools selected have two students who offer the General science programmes. The purposive sampling technique was used to select all students who offer the Technical and Agriculture programmes at the time of data collection for the study. This was to cater for the smaller numbers involved. In all, 46 and 47 students who offer the Technical and Agriculture programmes respectively participated in the study. Physics students who offer the General science programme in the participating schools were selected using proportionate stratified random sampling technique. This technique was contingent on the number of Agric and or technical students selected from each school.

From the 14 selected schools, there were 2000 Form 3 physcis students who offer the General Science programme, 46 (15 females and 21 males) offered Technical programme and 47 (10 females and 37 males) offered Agricultural Science. Out of the total of 2093 Form three physics students, 812 were females and 1281 were males. Three hundred and twenty-two students were randomly selected from the General Science programme based on Krecjie and Morgan's criteria. This was made up of 136 females and 186 males. Hence, the sample size for this study was 415 physics students. The sample was made up of 161 females (38.8%) and 254 males

(61.2%), with 202 (48.7%) age between 16-17 years, 193 (46.5%) aged 18 and above and only 20 (4.8%) were below 16 years.

The main instrument for data collection was a questionnaire. The questionnaire was named Students' Interest in Physics (SIP-Q). It was broadly divided into two sections. The first section dealt with demographic data about students' gender, school type and programme of study. In the second part of the SIP questionnaire students were asked to respond to twenty (20) items measuring their interest in physics. The 23 items on the interest scale (TSIP) were developed by the researcher after extensive review of related literature on students' interest in studying a subject in school. It followed a five-point likert scale with ratings ranging from 1-5 as follows: always disagree-1, rarely agree-2, sometimes agree-3, often agree-4 and always agree-5 for positive statements. Reliability coefficients of .92 was obtained for the overall student interest in physics scale (SIP-Q). This coefficient is considered very respectable for deciding on how appropriate the instrument is (Fraenkel and Wallen, 2001). The 415 participants responded to the 'Students' Interest in Physics Questionnaire (SIP-Q). The 23 items were reduced to three underlying factors using exploratory factor analysis. Three factors emerged which were named appropriatley as 'Career and future studies interest (CFSI)'; 'General school physics interest (GSPI)'; and 'Foundational physics interest (FPI)'. The FPI factor contained five items that measured the interestingness or trigerred situational interest of the participants. The GSPI factor (made up of 12 items) described the participants actions and inactions taken due to their deep-seated interest in school physics (physcis learnt and taught in school). Finally, the CFSI factor had six items that measured students' intention to reengage with physics after school as in choosing a career in physics or taking up physics in the university. The reliability coefficients and sample items are given in Table 2. Data analysis was done using both parametric (T-test, regression) and non-parametric (Mann-Whitney U and Kruskal-Wallis H) statistical tools in addition to means and standard deviations.

Table 1: Reliability coefficients and sample items of the interest factors

Interest Factor	**Sample item**	**Reliability Coefficient**
Foundational physics interest (FPI	I find physics to be interesting. I am always excited about physics.	.77
General school physics interest (GSPI)	I spend most of my spare time reading or working on physics related problems. I read a lot about physics.	.89
Career and future studies interest (CFSI)	I want to work in a field involving physics in the future. I will choose physics or physics related discipline in the university.	.84

IV. RESULTS AND DISCUSSIONS

To answer research question one, interest means were computed for an overall students' interest as well as means for three interest factors, namely, Career and future studies interest (CFSI), General school physics interest (GSPI) and Foundational physics interest (FPI) (Table 2). This was followed by an observation of the means and standard deviations to see the degree to which respondents were interested in physics. CFSI dimension was made up of items that sought to find out the extent to which students were interested in taking up a career or pursue physics to the tertiary level. GSPI measured students' interest in the physics taught and learnt at school whereas FPI measured students' beginning interest in physics.

Table 2: Descriptive statistics of interest factors (N=415)

Interest factors	Mean	Std. Deviation
TSIP (Overall)	3.42	.83
Career and future studies interest	3.19	1.05
General school physics interest	3.51	.91
Foundational physics interest	3.75	.95
Valid N (listwise)		

To interpret the mean score of students to determine their degree of interest, a standard as shown in Table 3 was developed based on the range of the five-point Likert scale.

Table 3: Format for interpreting degree of students' interest

Level	Range	Description
1	1.01 to 1.80	Very low
2	1.81 to 2.60	Low
3	2.61 to 3.40	Moderate
4	3.41 to 4.20	High
5	4.21 to 5.00	Very high

Based on this format and the result from Table 2, it could be seen that the students had an overall high interest in physics (M=3.42, SD= .83). Also, students' interest was high for Foundational physics interest (M= 3.75, SD=.95) and General school physics interest (M=3.51, SD=.91) factors. However, their interest in career and future studies factor was moderate (M=3.19, SD=1.05). .

Students interest in physics across gender, programme and school type

Research question two sought to find out if there existed any statistically significant differences in students' interest in physcis by gender, schooltype and programme of study. To achieve this, first, the observed means for the various classes under the variables of gender, schooltype and programme of study were compared to see if there were differences, and then followed by an appropraite test to check if the observed differences were statistically significant.

Students interest in physics across gender

It is observed from Table 4 that boys, in general, had higher physics (M=3.69, SD=.66) interest than girls' (M=3.01, SD=.90) for TSIP scale.

Table 4: Group statistics of males and females on interest

	Sex of respondent	N	Mean	SD
TSIP	Male	254	3.7	1.1
	Female	161	3.0	.7

To perform an independent samples t-test in order to compare the interest levels of male and females, assumption testing was done to ascertain its eligibility. Assumptions of largeness of sample size and independence of observation were not violated. However, test of normality using Kolmogorov Smirnov (Asymp sig = .001) and Shapiro-Wilk (sig. = .001) showed significant result (see Table 5). This means the distribution was not normal. Again, assumption of homogeneity of variance was also violated (F = 20.12, sig = .001). By this, a non-parametric equivalent - Mann-Whitney U test- was performed.

The Mann-Whitney U test showed a statiscally significant difference in interest between males (Mean rank = 243.58) and females [Mean rank = 151.86; t(413)= 11408.00, z =-7.594, p=.001] for the TSIP scale as indicated in Table 5. The magnitude of the difference in the means was large for TSIP (eta squared .14) (Cohen, 1988). This implies that male students have higher interest in studying physics than female students and the difference was statistically significant.

Table 5: Mann-Whitney U test results of interest by sex

Sex	N	Mean Rank	Mann-Whitney U	P
Male	254	243.58	11408.00	.001
Female	161	151.86		
Total	415			

Difference in students' interest by school type

Table 6 shows that students in boys only schools reported higher interest (M=3.74, SD=.69) in physics than mixed (M=3.49, SD=.75) and girls only (M= 2.78, SD=1.01) schools. Also, students from mixed schools reported higher interest in physics that those from girls' schools.

Table 6: Descriptive statistics of interest by school types

Type of School	N	Mean	Std. Dev
Boys only	61	3.7	.7
Girls only	60	2.8	1.0
Mixed	294	3.5	.8
Total	415	3.4	.8

In addition, students in mixed school showed significant interest in physics than students in Girls school. This could be due to the fact that boys in mixed schools could influence the girls to develop interest in the study of physics. That is, the higher interest recorded by students from mixed schools over students from girls' school may be attributed to the 'boys-factor' in physcis interest. This means the higher interest boys in general have in physics might have contributed to this overall higer interest for the mixed schools as compared to the girls' only schools.

Since assumptions of normality for the interest in physics variable and homogeneity of variances for the three independent variables (School type) were violated (Levene statistic=6.626, p=.001) Kruskal-Wallis H test was performed.

As shown in Table 7, there was a statiscally significant difference in interest across the three school types (chi-square = 34.004, p = .001).

Table 7: Kruskal-Wallis H test results of interest by school type

School type	N	Mean Rank	Chi-square	P
Boys only	61	252.21	34.004	.001
Girls only	60	130.87		
Mixed	294	214.57		
Total	415			

Though statistical significance was reached, the actual difference in mean scores between groups was moderate as evident in effect size statistics (eta squared = .11) (Cohen, 1988). Post hoc comparisms using the Dunnett C test indicated that the mean score of Boys only schools (M=3.74, SD=.68) was statiscally significantly different from Girls only schools (M=2.79, SD=1.01) and Mixed sex schools (M=3.49, SD=.75). The mean score of Mixed sex school was also statistically significantly different from girls only schools (see Table 8). The null hypothesis was therefore rejected. This implies that Boys only schools had the highest interest in studying physics followed by mixed schools and Girls' schools had the least.

Table 8: Multiple comparisons of school types using Dunnett C Test

(I) Type of school	(J) Type of school	Mean Difference (I-J)	Std. Error
Boys only	Girls only	.95431*	.15658
	Mixed	.24921*	.09751
Girls only	Mixed	-.70510*	.13735

This observation shows that students in boys only schools generally have higher interest in physics than students in Girls only schools which consolidate the general knowledge that boys in general are more interested in physics than girls (Murphy & Whitelege, 2006).

Difference in students' interest by programme of study

Descriptively, as seen from Table 9, Technical school students reported higher means of interest in studying physics [M=3.7, SD=.7] followed by Agricultural science students [M=3.7, SD =.7] compared to General science students [M=3.3, SD=.8]. The high interest of technical and Agricultural science students may be attributable to their personal interest in the subject that made them choose physics as one of their electives.

Table 9: Descriptive statistics of students' interest by programme of study

	N	Mean	Std. Deviation
Science	322	3.3	.8
Agric	46	3.7	.7
Technical	47	3.7	.7
Total	415	3.4	.8

Assumption for normality and homoscedasticity for the interest in physics variable was violated but homogeneity of variances for the three independent variables were not violated (Levene Statistic =1.213, p=.298). Once again, the Kruskal Wallis H test was employed to answer research question two on programme of study. Subjects were divided into three groups according to programme of study (Group 1: General science; Group 2: Agricultural science; Group 3: Technical).

As shown in Table 10, there was a statiscally significant difference in interest across the three school types (Chi-square = 12.615, p = .002).

Table 10: Kruskal-Wallis H test results of interest by programme

Programme	N	Mean Rank	Chi-square	P
Science	322	196.77	12.615	.002
Agric	46	245.77		
Technical	47	247.98		
Total	415			

Despite reaching statistical significance, the actual difference in mean scores between groups was small. The effect size calculated using eta squared was .03 (Cohen, 1988) and hence the difference was no practically significant. Post hoc comparisms using the Dunnette C test (Table 11) indicated that the mean score of Group 1 (M=3.3) was significantly different from Group 2 (M=3.7, p=.002) and Group 3 (M=3.7, p=.002). However, Group 2 did not differ from Group 3.

Table 11: Post hoc comparison of interest by programme of study

(I) programme of study	(J) programme of study	Mean Difference (I-J)	Std. Error
Science	Agric	-.34037*	.11566
	Technical	-.38300*	.11135
Agric	Technical	.04262	.11135

This observation shows that technical students generally had higher interest in physics than Agriculture and General science students but the magnitude of the difference was not practically significant.

V. DISCUSSIONS

Even though the Table 2 shows that students reported high interest in two interest dimensions, students' interest with respect to their desire to reengage with physics as measured by career and future interest in physics (CFIP) factor (M= 3.2, SD=1.1] was moderate. This lowered the overall mean for interest significantly (TSIP) (M=3.2) compared to the mean of FPI (M=3.75) and that of GSPI (3.51). The students were therefore moderate as to their desire to pursue physics further or take up a career in physics as was also observed by Laad (2011) and Varghese (2008). Both Laad and Varghese observed that there has been a sharp drop in the number of students choosing physics in tertiary institutions. The findings from this study are also consistent with Oon and Subramaniam (2013) observation that students can interested in physics and still fail to take up a career or pursue physics further in tertiary institutions. These findings also contradict the findings of Adeyemo (2010), Buabeng, Ossei-Anto and Ampiah (2014) and Krapp (2002) that physics is not popular with students and their interest is low. The observed differences between these findings and the previous studies that recorded low interest among students may be due to a number of factors. Firstly, a number of previous studies measured interest as a whole without considering that, interest could be measured at different levels such as students' general interest in physics taught and learnt at school (GISP) and students' interest in pursuing physics at a higher academic level or take up a career in the subject (CFIP). By this, it becomes difficult to generalise that students' interest is low. Because, very low means in items measuring these factors could have affected the grand mean of interest. Secondly, the time that elapsed between the previous studies and the current study might have brought various interventions that has raised students' interest in physics. Thirdly, the different geographical locations could also bring about the observed differences.

In addition, this observation also agrees with Oon and Subramaniam (2013) findings on Asian students. They found that Asian students were very interested in physics but were reluctant to pursue it further or take up a career involving physics. Acoording to Laad (2011), students' unwillingness to take up a career or pursue physics higher can be attributed to three factors: a) Fewer job opportunities. She explained that graduates of physics do not attract more job opportunities like graduates of commerce, engineering or medicine b) limited seats for further studies and research in physics and C) industrial needs and academia are not well linked. Students therefore become frustrated and discouraged when they graduate in physics and are unable to secure jobs. Hence, students will prefer more job-oriented courses in the university.

The finding that male students have significantly higher interest in studying physics than their female students agrees with the assertion that since physics is a male dominated field, the interest of males would be significantly higher than females and with Hoffmann's (2002) results of her German survey where it was emphasised that only 20% of girls and 60% of boys are interested about the topics discussed in physics lessons in grade 10 (cited in Lavonen et al., 2005).

Even though, the observation that technical students and Agricultural Science students generally had higher interest in physics than General science students, was not practically significant. The finding contradicts the general opinion that non-General Science students have lower interest in physics (Djudin, 2018; Modern Ghana, 2017). Also, there was no significant difference between the interest levels of Technical (M=3.7, SD=.7) and Agricultural Science students (M=3.7, SD=.7). Since this study did not investigate reasons for higher interest of the non-General Science physics students, we conjecture, though soundly, that this observation may be attributable to the individual interest (Hidi & Renninger, 2012) students in Technical and Agricultural Science programmes have in physics, and call for further studies in this regard. That is, unlike the General Science programme where physics is mostly compulsory for all students, it could be said that, mostly, only highly motivated students (from Technical and Agriculture) who know the value of physics in their chosen programme and career path opt for physics (Modern Ghana, 2017). This finding is however contrary to Hao's (2013) observation that Agricultural science students do not find physics to be very much related to their programme of study and hence reported lower interest in physics.

VI. CONCLUSIONS

From the findings of this study, a number of conclusions can be drawn. Firstly, Students, generally, have high interest in some dimensions ('General School Physics Interest' and 'Foundational Physics Interest') of studying physics but surprisingly do not want to pursue physics at a higher level or even take up a career in physics. Secondly, in accordance with the popular opinion, males were generally found to be more interested in physics than females in the schools studied. Also, students from Boys only schools werre more interested in physics than mixed and girls' only schools respectively. However, Technical and Agricultural science students were unexpectedly found to be more interested in physics than General science students. This is finding is surprising as it is generally expected that General science students should be more interested in physics that their 'non-science' counterparts. This finding is contributing to the body of knowledge in science education.

Implications and Suggestions

Students interest was found to be to different degrees on different dimensions of the interest scale. This finding implies that it is possible for a student to be interested in physcs or a subject learnt or taught in school and still not be interested in taking up career or pursue the subject to a higher level (Oon & Subramaniam, 2013). This usually is dependent on their exposure to the carreer opportunities or remunrations attached to the field. Teachers should therefore expose the learners to carreer opportunities for physics graduates and the need to pursue physics to a higher level in the course of physics lessons (Laad, 2011). Also, the findings of this study bring to light the fact that in general students have a moderate interest in physics and are not so much willing to take up career or further studies in physics. In view of this further research should be conducted to ascertain and elucidate the current prevailing factors responsible for students dwindling desire to pursue physics related courses in the university or take up a career in physics and the find ways to mitigate these.

Furthermore, female students' lower interest in physics suggests that there is the need for physics teachers to adopt girls favourable teaching methodologies in the teaching and learning of physics. Also, there is the need to adopt ways to motivate girls to develop interest in Physics. In addition, there is the need for girls to be encouraged to learn physics alongside their male counterparts as girls this could improve their interest in the subject. Finally, the observation that technical as well as Agricultural science students tended to have higher interest levels compared to General science students implies that students should be made to select their elective subjects with expert guidance. As it is obvious that when students choose the subjects to study, they tended to develop higher interest which leads to higher achievements. Based on the findings of this study, the following suggestions were made:

1. Students should be exposed to the career prospects of physics graduates and consistently be told the relevance of the physics concepts they are exposed to by their teachers using daily life applications.
2. All stakeholders; Ministry of Education, Ghana Education Service, school management and teachers should make conscious effort to ascertain the challenge of girls in physics and take steps to improve their interest.
3. Girls' specific management practices should to be employed by physics teachers in their classroom in order to disabuse the minds of young women from thinking that physics is meant for men.
4. Students must be given the opportunity to choose (with expert guidance) their programmes and subjects of study instead of fitting them into already predetermined programmes or courses.

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REFERENCES

[1] Adeyemo, S. (2010). Teaching/learning physics in Nigerian secondary schools: Background and classroom correlate of students in physics. Asia Pacific Education Review (19); 307–317. https://doi.org/10.1007/s12564-018-9522-0

[2] Aggarwal, J. C. (2007). Essentials of Educational Psycholgy. Masjid Road, Jangpura, New Delhi, Vikas Publising House.

[3] Ainley, M. D., Hillman, K., & Hidi, S. (2002). Gender and interest processes in response to literary texts: Situational and individual interest. Learning and Instruction, 12,411–428.

[4] Angell, C., Guttersrud, O., Henriksen, E., & Isnes, A. (2004). Physics: Frightful, but fun. International Journal of Science Education, 88, 683–706.

[5] Anamuah-Mensah, J., Mereku, D.K. & Ampiah, J.G. (2009). TIMSS 2007 Ghana Report: Findings from IEA's trends in international mathematics and science study at the eighth grade. Accra: Adwinsa Publications (Gh) Ltd.

[6] Åström, M. (2008). Defining Integrated Science Education and Putting It to Test. Submitted to the Faculty of Educational Sciences at Linköping University in fulfilment of the requirements for the degree of Doctor of Philosophy Studies in Science and Technology Education. Department of Social and Welfare Studies, S-601 74, No 26

[7] Awodun, et.al. (2014). Students' variables as predictors of secondary school students'performance in physics. International Journal of Scientific and Research Publications, 4(8),1–6.

[8] Buabeng, I. Ampiah, J. A. & Nelson-Quarcoo, R. (2012).

[9] Buabeng, I., Ossei-Anto, T. A. & Ampiah, J. A. (2014). An Investigation into Physics Teaching in Senior High Schools. World Journal of Education, 4(5); 40-50.

[10] Cassidy, R., Catter, S., Crawford, C. & Dythan, S. (2018). How can we increase girls' uptake of maths and physics A-level? The Institute for Fiscal Studies. ISBN 978-1-912805-08-2

[11] Cheung, D. (2018). The key factors affecting students' individual interest in school science lessons. International Journal of Science Education, 40(1), 1-23. DOI:10.1080/09500693.2017.1362711

[12] Cohen, L., Manion, L., & Morrison, K. (2007). Research methods in education (5th ed.). London: Routledge Farlmer Publishers.

[13] Creswell, J. W. (2012). Educational Research: Planning, conducting and Evaluating educational Research (4th ed.). Boston, MA: Pearson Education Inc.

[14] Darlington, H. M. (2017). Understanding and developing student interest in science: an investigation of 14–16-year-old students in England. Doctoral thesis (Ph. D), UCL (University College London).

[15] Djudin, T. (2018). How to Cultivate Students' Interests in Physics: A Challenge for Senior High School Teachers. Jurnal Pendidikan Sains 6(1), 16–22. DOI: 10.17977/jps.v6i1.10543.

[16] Dobson, I.R. (2006). Science at the crossroads? The decline of science in Australian higher education. Journal of Tertiary Education and Management, 12(2), 183–195. DOI: 10.1080/09500690412331314469

[17] Francis, B., Archer, L., Moote, J., de Witt, J., & Yeomans, L. (2017). Femininity, science, and the denigration of the girly girl. British Journal of Sociology of Education, 38(8), 1097-1110, DOI: 10.1080/01425692.2016.1253455

[18] Hao, E. J. (2013). Preliminary exploration of the reform of Physics teaching involved in agriculture. In 2013 the International Conference on Education Technology and Information System (ICETIS 2013, June), 1146-1149. Atlantis Press.

[19] Hasni, A. (2015). Student's Interest in Science and Technology and its Relationships with Teaching Methods, Family Context and Self-Efficacy. International Journal of Environmental & Science Education,10(3), 337-366

[20] Hidi, S. & Renninger, K. A. (2006). The four-phase model of interest development. Educ. Psychol, 41, 111–127. doi: 10.1207/s15326985ep 4102-4

[21] Renninger, K. A. & Hidi, S. E. (2016). The power of interest for motivation and engagement, TESOLANZ Journal, 28, 109 -111, ISSN 1172-9694

[22] Hyde, J. S. (2014). Gender similarities and differences. Annual review of psychology, 65, 373– 398.

[23] Hoffman, L. (2002). Promoting girls' interest and achievement in physics classes for beginners. Learning and Instruction, 12 (4), 447-465.

[24] Institute of Physics (2012). It's different for Girls: the influence fo schools. https://www.iop.org/sites/default/files/2019-04/its-different-for-girls.pdf

[25] Ivowi, U. (2001). Role of Teachers in Motivating Students' Interest in Science and Mathematics. IICBA–Newsletter, 3(1), 1-7. Retrieved from http://unesdoc.unesco.org/images/0023/002315/231596e.pdf

[26] Keller, M., Neumann, K., & Fischer, H. E. (2017). The impact of physics teachers' pedagogical content knowledge and motivation on students' achievement and inter- est. Journal of Research in Science Teaching, 54(4), 586–614.

[27] Kiruki & Orodho (2015). Infleunce of Students and Teachers Attitudes on Students' Enrollment in Physics in Secondary Schools in Imenti South Constituency, Meru County, Kenya. Journal of Humanities and Social Science 20(4), 1-11.

[28] Krapp, A. (2002). An educational-psychological theory of interest and its relation to SDT. In E. L. Deci & R. M. Ryan (Eds.), Handbook of Self-Determination Research, 405–427. University of Rochester Press.

[29] Krapp, A. (2002). Structural and dynamic aspects of interest development: Theoretical considerations from an ontogenetic perspective. Learning and Instruction 12(4):383-409. DOI:10.1016/S0959-4752(01)00011-1,30(3),607–610. https://doi.org/10.1177/001316447003000308

[30] Krapp, A. (2007). An educational-psychological conceptualisation of interest. Int J Educ Vocat Guid, 75-21. D01 10.10071~10775-007-9113-9

[31] Krogh, L. B. & Thomsen, P. V. (2005). Studying students' attitudes towards science from a cultural perspective but with a quantitative methodology: Border crossing into the physics classroom. International Journal of Science Education, 27(3), 281-302.

[32] Kunter, M., Baumert, J. & Köller, O. (2007). Effective classroom management and the development of subject-related interest. Learning and Instruction. 17. 494-509. 10.1016/j.learninstruc.2007.09.002.

[33] Laad, M. (2011). Causes Responsible for Declining Interest of Students in Learning Physics at Higher Level: An Indian Perspective. International Journal of Pure and Applied Physics, 7 (2), 151-158.

[34] Laal, M., Naseri, A. S., Laal, M., & Kermanshahi, Z. K. (2013). What do we achieve from learning in collaboration? ScienceDirect, 93, 1427-1432.

[35] Lavonen, J., Byman, R., Juuti, K., Meisalo, V., & Uitto, V. (2005). Pupil Interest in Physics: A Survey in Finland. Nordina, (2), 1-14.

[36] Lyons, T. (2006). The puzzle of falling enrolments in physics and chemistry courses: Putting some pieces together. Research in Science Education, 36(3), 285–311.

[37] Makarova E., Aeschlimann, B. & Herzog, W. (2019). The Gender Gap in STEM Fields: The Impact of the Gender Stereotype of Math and Science on Secondary Students' Career Aspirations. Bernhard Ertl (Ed.). Frontiers in Education, 4(60), doi: 10.3389/feduc.2019.00060

[38] Mitchell, E. (2015). An exploration of girls' attitudes to science and the barriers to selecting A-level physics. Thesis submitted in part-fulfilment of the requirements for the degree of Master of Education of the University of Cambridge, Faculty of Education.

[39] Murphy, P. & Whitelegg, E. (2006) Girls and physics: continuing barriers to ‘belonging’. The Curriculum Journal, 17(3), 281-305, DOI: 10.1080/09585170600909753
[40] National Council for Curriculum and Assessment (NaCCA) (2019). Science curriculum for primary schools (Basic 4-6). Ministry of Education: Accra, Ghana.
[41] Oon, P. T. & Subramaniam, R. (2013): Factors Influencing Singapore Students' Choice of Physics as a Tertiary Field of Study: A Rasch analysis, International Journal of Science Education, 35(1), 86-118.
[42] Smith, T. (2012). Engaging girls in physics: Some suggestions for “girl friendly’ teaching strategies. Advances in Gender and Education, 3, 13-19.
[43] Spall, K., Stanisstreet, M., Dickson, D., & Boyes, E. (2004). Development of school students’ constructions of biology and physics. International Journal of Science Education, 26(7), 787–803.
[44] Varghese, G. (2008). Declining Trend in Science Education and Research in Indian Universities. In H. Vessuri & U. Teichler (Eds.), Universities as Centres of Research and Knowledge Creation: An Endangered Species? (201–212). Retrieved from https://doi.org/10.1163/9789087904807_019
[45] WAEC. (2014). Chief examiner report. Accra: WAEC Press.
[46] WAEC. (2015). Chief examiner report. Accra: WAEC Press.
[47] WAEC. (2016). Chief examiner report. Accra: WAEC Press.
[48] WAEC. (2017). Chief examiner report. Accra: WAEC Press.
[49] WAEC. (2018). Chief examiner report. Accra: WAEC Press.
[50] WAEC. (2019). Chief examiner report. Accra: WAEC Press.
[51] Wenno, I. H. (2014). The correlation study of interest at physics and knowledge of mathematics basic concepts towards the ability to solve physics problems of 7th grade students at junior high school in Am- bon, Maluku province, Indonesia. Education Research International, 2015, 1–6. https://doi.org/ 10.1155/2015/396750.
[52] Williams, C., Stanisstreet, M., Spall, K., Boyes, E., & Dickson, D. (2003). Why aren’t secondary students interested in physics. Physics Education, 38(4), 324–329.
[53] Woolnough, B.E. (1993). Teachers’ perception of reasons students choose for, or against, science and engineering. School Science Review, 75(27), 112 – 117.