



## Teaching and Learning Physics in Senior High Schools in Ghana: The Challenges and the Way Forward

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### *Authors' contributions*

*This work was carried out in collaboration among all authors. Author ISC designed the study, wrote the protocols and wrote the first draft of the manuscript. Author BBF managed the literature search and author EA dealt with the data entry and analyse the data. All authors read and approved the final manuscript.*

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### **ABSTRACT**

**Aim:** Considering the technological age that we find ourselves in this 21<sup>st</sup> century, it would be expected that, the number of students willing to study physics will increase exponentially. However, reports indicate a sharp reduction of students in physics classrooms. This study therefore sought to identify the challenges and way forward for improving physics teaching and learning in Senior High Schools in Ghana.

**Study Design:** Descriptive cross-sectional survey was used for the study.

**Methodology:** The main instrument used for the study was questionnaire. The sample size for the study comprised both physics teachers and students. The sample size for the teachers was made up of 38 teachers which comprised 34 males and 4 females who were selected using the convenient sampling approach. The sample size for the students consisted of 750 students selected by stratified sampling of which 520 were males and 230 were females.

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**Results:** While the teachers perceived the most important factor affecting the teaching and learning of physics to be students-related problem, the students on the other hand perceived the major challenge affecting the teaching and learning of physics to be teacher-related. For both teachers and students, provision of adequate resources like well-equipped laboratories for teaching and learning is an assured way of improving the teaching and learning of physics in senior high schools in Ghana.

**Conclusions:** The challenges in teaching physics as perceived by both teachers and students are teacher related, student-related and resource-constraints. It was recommended that the government must make conscious effort to provide the schools with adequate science resources to facilitate the practical approach to teaching and learning of physics.

*Keywords: Teaching; learning; Physics; challenges; way forward.*

## 1. INTRODUCTION

Every country can develop when its citizenry are well educated. Education in science and technology has become the backbone of development in recent times. There can never be any better understanding of science and technology without the study of physics. Physics is described as an ancient scientific discipline that studies everything from basic philosophical questions to everyday phenomena, from nature's smallest building blocks to the most distant galaxies, from high-tech satellites to processes in the human body [1]. The study of physics in schools, colleges and universities is therefore very crucial since it is the basis of engineering and technology. Students with physics background are able to reason both deductively and inductively and approach new situations with a high degree of precision and accuracy. Physics helps the learners to develop critical thinking due to its high reliance on mathematical concepts and logic.

Considering the technological age that we find ourselves in this 21<sup>st</sup> century, it would be expected that, the number of students willing to study physics will increase exponentially. However, reports indicate a sharp reduction of students in physics classrooms [2,3,4] as too few students opt to study physics [5]. Physics is not attractive to young people nowadays [6]. In a survey conducted by Durham University YELLIS project over the period of 1999 to 2004, it was found out that physics was perceived as the least popular subject by students [2].

The main factors that account for students' lack of interest in physics have been attributed to both teachers and students [7,8,9]. Physics teachers can have great positive effect on students' understanding and appreciation of the subject [10]. However, the teachers themselves have problems in teaching physics [11,12]. They show

poor teaching skills and lack of mastery of content [7] as Heras [11] asserts that they "follow traditional teaching approaches based heavily on solving standard problems and learning by rote, with no hint of free inquiry or discussion". This is supported by Reddish and Steinberg [13] who emphasized that, physics instructors present physics topics to students without explaining the concepts, skills or attitudes they want students to develop. On his part, Ponchaud [14] reports that the teaching of physics is characterized by the lack of social context and emphasis on individual response rather than group discussion. Several empirical studies confirm this state of teaching of physics where students describe physics teaching as "boring", "dry", "without innovation", "chalk and talk" [1,15,13,9,5]. These poor physics instructions do not inspire many students to pursue further study of physics [10].

The problems with teachers having difficulties in delivering physics could be due to the fact that most teachers of physics may not have the needed training. For example, in the USA, it is reported that more than 50% of teachers of high school physics do not have a degree in physics or physics education [16]. Some of the physics teachers are trained in other sciences, engineering and business disciplines [16]. The situation is not quite different in Ghana as a study by Buabeng, Ossei-Anto and Ampiah [17] reveals that some physics teachers' professional qualifications are in project management and journalism. For the physics teachers who have the right qualification, courses and experiences which have the possibility of producing valuable knowledge are not normally available during initial physics teacher education [10]. They added that, physics teachers do not have the needed content knowledge and pedagogical preparation for teaching physics effectively. This is supported by a study in Ghana by Buabeng et al. [17] who concluded that "most of the physics teachers do not have academic qualification

and/or certificate in education. What this means is that these teachers may lack the pedagogical knowledge and they are unfamiliar with the teacher actions that support and promote student learning”.

A Task Force on Teacher Education in Physics set up by Association of Physics Teachers, and the American Institute of Physics “found that, except for a handful of isolated models of excellence, the professional preparation of physics teachers is largely inefficient, mostly incoherent, and completely unprepared to deal with the current and future needs of the nation’s students” [10]. A study by Buabeng, Conner and Winter [18] on physics teachers’ view about their initial teacher education (ITE) reports that, teachers were not sure that their ITE provided them with the appropriate knowledge for teaching physics. The researchers suggested that the content knowledge teachers acquired from their ITE was not adequate to address the teachers’ need.

Some of the challenges in physics teaching and learning are students-related even though Lasry et al. [12] see this shifting of the blame from teachers to students as “quite problematic”. Students have problems in understanding physics concepts. Some students have difficulties understanding a particular “representational mode” like a graph in physics [19]. Mathematics is another area of difficulty for students as teachers complain about students insufficient mathematical abilities to be able to use physical equations. Students have difficulty in understanding mathematical language [20,21, 22,23,24]. Some students see the capacity to do physics as something special which they do not possess. This mind-set affects their level of success in physics. Also some group of students like girls feel they do not belong to the physics classroom [25]. Whiles there may be literature on the challenges and way forward for improving the teaching and learning of physics, there is a lack of systematic study in the Ghanaian context. This study was therefore conducted to close the literature gap in the Ghanaian context. The study was therefore guided by the following questions;

1. What are the challenges affecting the teaching and learning of Physics in senior high schools in Ghana?
2. What are the ways forward for improving the teaching and learning of Physics in senior high schools in Ghana?

## 2. METHODS

Descriptive cross-sectional survey was used for the study to seek answers to the research questions. The main instrument used for the study was questionnaire which was adapted from Buabeng [15]. The questionnaires used for the data collection were closed-ended. The questionnaire was multi-dimensional in nature with a Likert scale and the items were scaled using 5 point Likert scale which started with “Strongly Disagree to Strongly Agree. The questionnaire consisted of two main sections with the first section soliciting opinion of respondents on the perceived problems whilst the second section dealt with the way forward aside the biographic section.

The sample size for the study comprised both physics teachers and students. They were drawn from government Senior High Schools (SHS) in Central, Western, Western-North and parts of Ashanti region. The sample size for the teachers was made up of 38 teachers which comprised 34 males and 4 females who were selected using the convenient sampling approach. The teachers who participated in this study had a wide variety of educational backgrounds and experiences with their educational qualifications ranging from first degree to second degree and their number of years of teaching ranging between 2-17 years. The sample size for the students consisted of 750 students (made up of SHS 2 and SHS 3 students) selected by stratified sampling of which 520 were males and 230 were females.

## 3. RESULTS

This section presents the results of challenges and way forward from improving physics teaching in SHS in Ghana from both students and teachers perspectives.

### 3.1 Challenges Facing the Teaching and Learning of Physics

The results of the challenges in the teaching and learning of physics as perceived by students is presented in Table 1.

From the point of view of the students as shown in Table 1, the most important challenges facing the teaching and learning of physics in Ghanaian senior high schools are; Too little practical (M= 4.3, SD=1.1), Inadequate laboratory equipment (M=4.1, SD=1.5), Subject too mathematical (4.1,

SD=1.4), Poor teaching approach (M=4.1, SD=1.0) and Difficult nature of the subject (4.0, SD=1.4). These are followed by other challenges like; broad content (M=3.7, SD=1.6), topics too theoretical and abstract (M=3.5, SD=1.3) with subject not applicable (3.0, SD=1.5) being among the least perceived challenges.

From the teachers' point of view as shown in Table 2, the most important challenges facing the teaching and learning of physics in Ghana are students misconception about physics (M=4.4, SD=0.6), inadequate laboratory equipment (M=4.2, SD=0.5), insufficient classroom teaching time (M=4.0, SD=0.2) and parental and societal perception about the difficult nature of physics. These are followed by other challenges like; overloaded curriculum (M=3.9, SD=0.6), the connection between mathematics and physics (M=3.5, SD=0.8) and inadequate qualified physics teachers (M=3.2, SD=0.7). Among the challenges, inadequate teacher subject knowledge (2.0, SD=1.1) and inadequate career path for physics learning (2.7, SD=1.7) were perceived to be the least.

### 3.2 Way Forward Improving Physics Teaching and Learning

As seen from Table 3, the students believe the most important factors to consider in improving physics teaching include; the teaching of physics must be more practical (M=4.3, SD=1.6), improvement in teaching approach (M=4.0, SD=1.1), emphasizing on the application aspect of the subject (M=4.1, SD=1.3), Less emphasis on formulas and calculation (M=4.1, SD=1.5) and provision of adequate resources for teaching and learning (M=4.0, SD=1.3).

As shown in Table 4, for the teachers, the most important way forward for improving physics teaching and learning include: more teacher

professional development on physics practical (M=4.2, SD=0.9), providing adequate resources for teaching and learning (M=4.1, SD=0.5), reduction in content (M=4.1, SD=0.9) and better salary (M=4.0, SD=0.8).

## 4. DISCUSSION

While the teachers perceived the most important factor affecting the teaching and learning of physics to be students-related problem that is students' misconception about physics, the students on the other hand perceived the major challenge affecting the teaching and learning of physics to be teacher-related that is too little practical.

Inadequate laboratory equipment was another major challenge which both students and teachers believe affects the teaching and learning of physics in SHS in Ghana. This perhaps explains the reason why the students indicated that, there is too little practical in the teaching of physics. Physics is a practical subject which requires hand-on activities in a well-equipped laboratories. If laboratory equipment are not available to support practical teaching, then teachers will resort to teacher-centred approaches like lecture methods, question and answer which are known to be the prevalent methods of teaching physics in Ghana [17,26]. These teacher-centred approaches to teaching physics do not make the subject enjoyable to students making some think that physics is a difficult subject which is not meant for all students especially girls [25].

Mathematics plays a very important role in physics. It characterizes the way in which knowledge is gained in physics. Therefore for physics and its nature to be properly conveyed, mathematics is a necessary element [22].

**Table 1. Challenges facing the teaching and learning of Physics as perceived by students**

Item	Mean	Std. deviation
Too little practical	4.3	1.1
Difficult nature of the subject	4.0	1.4
Subject not applicable	3.0	1.5
Content too broad	3.7	1.6
Subject is too mathematical	4.1	1.4
Topics are too theoretical and abstract	3.5	1.3
An overloaded curriculum	3.4	1.4
Poor teaching approach	4.1	1.0
Inadequate qualified physics teachers	3.2	1.2
Inadequate laboratory equipment	4.1	1.5
Lack of good text books	3.2	1.5

**Table 2. Challenges facing the teaching and learning of Physics as perceived by Physics teachers**

Item	Mean	Std. deviation
Students misconceptions about physics	4.4	0.6
Parental and societal perception about the difficult nature of physics	4.0	0.9
The connection between mathematics and physics	3.5	0.8
Inadequate career path for physics learning	2.7	1.0
Inadequate teacher subject knowledge	2.0	1.1
An overloaded curriculum	3.9	0.6
Insufficient classroom teaching time	4.0	0.2
Inadequate qualified physics teachers	3.2	0.7
Inadequate laboratory equipment	4.2	0.5

**Table 3. Way forward improving Physics teaching and learning as perceived by Physics students**

Item	Mean	Std. deviation
Teaching must be more practical	4.3	1.6
Applications aspect of the subject should emphasized	4.1	1.3
Less emphasis on formulas and calculation	4.1	1.5
Reduction in content	3.6	1.4
Improvement in teaching approach	4.0	1.1
More competent physics teachers	3.4	1.0
Providing adequate resources for teaching and learning	4.0	1.3
Provision of good text book	3.8	1.4

**Table 4. Way forward for improving Physics teaching as perceived by the Physics teachers**

Item	Mean	Std. deviation
Better training of physics teachers	2.6	1.0
Physics cluster meetings to collaborate ideas on physics practical	3.1	1.0
More teacher professional development on physics practical	4.2	0.9
More physics graduates encouraged and/or supported to be trained as teachers	3.8	0.6
Providing adequate resources for teaching and learning	4.1	0.5
Reduction in content	4.1	0.9
Better Salary	4.0	0.8

Despite the importance of mathematics in conveying and understanding physics, students perceive the mathematical nature of physics as a challenge to the teaching and learning of physics.

For both teachers and students, provision of adequate resources like well-equipped laboratories for teaching and learning is an assured way of improving the teaching and learning of physics in senior high schools in Ghana. The students also suggested that, improvement in the teaching approaches of physics can improve physics learning. One important approach to improving the teaching and learning of physics is the use of interactive teaching methods [15] which involve “interactive engagement of students in heads-on (always)

and hands-on (usually) activities which yield immediate feedback through discussion with peers and or instructor” [27]. A key feature of the interactive approaches to teaching is the emphasis on knowledge construction by student rather than knowledge acquisition. For such an improvement in teaching to occur, the students believe physics teaching must be more practical with more emphasis on the application aspect of the subject and less emphasis on formulas and calculation.

For the teacher, the way forward for improving physics teaching is providing teachers with more professional development especially on physics practical activities. This suggestion is in line with students call for more practical approach to the teaching of physics. The implication is that the

physics teachers' knowledge on how to make physics more practical is limited and they need new skills in that area which can come in the form of professional development. "Professional development can provide a lot of benefits to the teachers in terms of boosting their confidence, providing opportunity for them to experience and apply new skills and improving their content and pedagogical knowledge" [28]. The teachers also believe that reducing the physics content and providing them with better salary are other ways of improving the teaching and learning of physics in Ghana. It has been shown that physics content is the least covered among three elective science subjects of biology, chemistry and physics in SHS in Ghana. In a study conducted by Buabeng et al. [17], it was shown that, the level of coverage for physics in an academic term as indicated by teachers was about 80% with only 4.8% of the teachers being able to achieve 100% coverage of the content for the term. This implies that physics teachers may not be able to cover all the content so they believe reducing the content will improve the teaching and learning of physics in senior high schools Ghana. Teachers in Ghana go on strike complaining about their poor conditions of service. They engage in so many extra works to keep up with the economic situation in the country. This can affect their level of preparation and delivery in the classroom. It has been shown that some physics teachers in Ghana have qualification in project management which they believe can be used to search for better paying jobs rather than having professional qualification [17]. It comes as no surprise that the physics teachers believe providing them with better salary can improve physics teaching in the country.

## 5. CONCLUSION AND RECOMMENDATION

From the study it can be concluded that the teaching and learning of physics in Ghanaian senior high schools is plagued with some challenges. These challenges as perceived by both teachers and students are teacher related, student-related and resource-constraints. While the teachers perceived the most important challenge affecting the teaching and learning of physics to be students-related, the students however perceived the major challenge affecting the teaching and learning of physics to be teacher-related. This blame-game situation will ultimately affect students' performance in physics

in the West African Senior High School Certificate Examination.

The way forward for improving physics teaching and learning in the senior high schools for both teachers and students is to provide adequate resources. This can help make the teaching and learning of physics more practical for students to understand and appreciate the subject which will in turn increase the number of students pursuing physics and its related programmes in the tertiary institutions. For the teachers, one of the most important way forward for improving the teaching and learning of physics in SHS is giving teachers more opportunities for professional development especially in physics practical while for the students it is making the teaching of physics more practical. It is interesting to note that while the teachers perceived the most important challenge in physics teaching to be student-related, their most important way forward is teacher-related.

It is recommended that regular professional development should be organized for physics teachers in the SHS on practical approaches to teaching physics. Also government must make conscious effort to provide the schools with adequate science resources like well-equipped laboratories to facilitate the practical approach to teaching and learning of physics.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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